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# TOWN AND COUNTRY PLANNING AS A SOCIAL SERVICE

AT the recent meeting at Birmingham of the British Association considerable interest was taken in a tour of Birmingham and the Black Country, arranged more particularly for the members of Sections E (Geography), F (Economics) and G (Engineering), by the West Midland Regional Planning Group By a combination of statistical analysis and shrewd observation, this voluntary and independent body, which was formed in 1941, has collected and presented in its successive surveys "English County" (dealing with Herefordshire), "Land Classification in the West Midland Region", and "Conurbation", a survey of Birmingham and the Black Country, some of the fundamental data on which future planning policy must be based The tour may be regarded as a further effort to awaken and sustain in a section of the scientific community the public interest which is essential if town and country planning is to be effective

Town and country planning has, in fact, to-day become, as a recent broadsheet (No 316) from Political and Economic Planning points out, a major social service in which local and central government co-operate This broadsheet, which is one of the series dealing with the implications for an active democracy of some of the services which affect the lives of people in their local communities, describes briefly the present Town and Country Planning Act of 1947, and it examines, not the administrative and technical problems which arise, but rather the more general questions of the nature of town and country planning, its meaning for the ordinary citizen and the way it fits into the British pattern of democracy It shows that physical planning on the scale required is only possible with the understanding and support of those who are being planned for—the public—and that if it fails to hold popular support town planning will lose the only driving force capable of making it an effective social measure

The broadsheet shows only too plainly that there are real doubts as to whether local authorities will use the wide powers which they have been given over the future development of their areas with the full support of the public, or whether they will use them effectively at all The question is whether our democratic institutions will carry through the major reforms required without becoming less democratic in the process, and the broadsheet directs attention to some of the dangers which attend any concentration of power in the hands of fewer authorities, even for sound technical and administrative reasons

In town and country planning, the powers entrusted to the local authorities are very wide, affecting, potentially at least, the whole of the physical environment of the individual Moreover, planning is a process which shows its positive effects only over a comparatively long period It does not impinge on the individual in the same way as the National Health Service does, and he has little direct motive or incentive to take an interest in it unless some private plan of his own is affected When this happens, the individual tends either to protest to the local planning authority or to appeal to the Minister Planners are thus liable to find that their closest contacts with the public are with those members of it who have real or imagined cause for complaint They tend in consequence to decide that the public is obstructive, and has to be circumvented in its own interest

There are other factors which encourage both the central and local authorities to feel that the less the public knows about their planning schemes the less trouble they will have The task of planning, in so far as it is not purely technical, is largely one of reconciling, or striking a workable balance between, a whole series of divergent interests, private and public, short-term and long-term It may seem to the planner not only that the layman can have few constructive suggestions to offer in such a complicated process, but also that the need to consult the public may upset the nice balance of needs and counter-claims which he has achieved in his plan

In spite, however, of the further danger of arousing public expectations which the slender resources for building and development in Britain, and the inevitably slow pace of progress, will deny fulfilment for a matter of decades, failure to bring the public to understand and approve the aims of such schemes would be a mistake Town planning has already to contend with the often conflicting demands of powerful public and private interests, as well as with the pressure of social forces, such as population movement, which we have not yet learnt to control Its own technical immaturity and lack of experience constitute further obstacles which could become a real danger if the gulf between planners and planned be allowed to develop The broadsheet issued by Political and Economic Planning is not so much a warning to the planners as a challenge to every citizen of goodwill, and to all who have specialized knowledge in some of the fields concerned, to play their part in filling or bridging that gulf, and in securing not merely a sympathetic and helpful handling of points of difficulty by local planning authorities, but also a widespread public understanding of what is involved A sustained interest must be promoted in the processes by which the changes are to be concerted, both at the local level and at the broader national level where the claims for land for the military and electricity authorities, for example, have to be reconciled with those for agriculture and national parks

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## STRUCTURE OF THE UNIVERSE

### The Structure of the Universe

An Introduction to Cosmology By Dr G J Whitrow (Hutchinson's University Library, No 29 ) Pp 171 (London Hutchinson's University Library, 1949 ) 7*s* 6*d* net

DR WHITROW is to be congratulated on this survey of the cosmologies of essentially the pre-1939 period The remarkable achievements of Hubble and his colleagues are described in detail—distance measurements, the velocity-distance law, and the large-scale uniformity of the distribution of matter in space being fully and adequately treated Then follow two chapters that deal with space-time and the theory of relativity These are written in a fluent, expert style and should prove of great val[illegible] to the lay reader They provide an excellent in[illegible]duction to the difficult problems of cosmology th[illegible] are treated in the last part of the book

In cosmology more significance is attached to a few observational results than in any other branch of science At first the uniformity of space and the red-shifts of the spectra of the extra-galactic nebulæ formed almost the only evidence available to cosmologists, and it was perhaps natural that some men of science should have come to regard this as a somewhat flimsy basis for the support of such weighty matters But, as Einstein himself has pointed out, it is difficult to gainsay the orthodox interpretation of the red-shifts without undermining the whole structure of physical science Nevertheless, it is of the first importance that our store of observational knowledge on this subject should be extended to the maximum degree, and it is for this reason that such great efforts have been made by Hubble to obtain crucial information from nebular counts The completion of this work is only now within sight In the meantime, by good fortune, vital new information has accrued from developments in astrophysics Most important are, first, that several methods of deriving the ages of the stars within our own galaxy all yield results close to 4,000 million years, and second, that the galaxies must have condensed from a more diffuse background Both these new requirements have a serious impact on many of the older cosmological theories

Dr Whitrow discusses the age of our galaxy at length, and directs attention to the discrepancy between the four thousand million years given by astrophysics and the very short age of the universe—no more than two thousand million years—demanded by many systems of cosmology Perhaps even greater weight might have been attached to this discrepancy, especially in the case of Milne's kinematical theory Milne was able to avoid many of the difficulties of other cosmologies by means of his dual time-scale But this no longer suffices to explain away the ages of the stars, which are now determined by a method that uses the physical time-scale This gives four thousand million years, in agreement with methods that use the dynamical time-scale

Although this review is not intended to be critical of Dr Whitrow's book, there is one error that should be pointed out In the final paragraph on p 147, Milne's explanation of the origin of angular momentum is highly commended. This part of Milne's theory has always seemed to the reviewer to be open to the serious criticism that many satellites of the great planets show no evidence of a large spontaneous increase of angular momentum Also, Dr Whitrow is wrong in saying that apart from Milne's theory there is no explanation of the origin of the spins of the galaxies For this follows without difficulty in any theory that regards the galaxies as condensations in a diffuse gaseous medium

But for the rest, the book is eminently readable and is packed with a fund of interesting historical details It cannot fail to be a great success with all who are interested in the fascinating problems of cosmology

F HOYLE

# TECHNOLOGY OF POLYMERIC MATERIALS

### Fundamentals of Synthetic Polymer Technology in its Chemical and Physical Aspects

By R Houwink (Elsevier's Polymer Series, No 1 ) Pp xii+258 28*s*

### Elastomers and Plastomers

Their Chemistry, Physics and Technology Edited by R Houwink (Elsevier's Polymer Series, No 3 ) Vol 1 General Theory Pp xiv+495 52*s* 6*d* Vol 2 Manufacture, Properties and Applications Pp. xvi+515 50*s* 6*d* Vol 3 Testing and Analysis Tabulation of Properties Contributed by B B S T Boonstra, A G Epprecht, R Houwink, J H Teeple, J W F van't Wout Pp 174 27*s* 6*d*

(New York and Amsterdam Elsevier Publishing Co , London Cleaver-Hume Press, Ltd , 1948–50 )

WHEN chemistry is receiving so much publicity concerning the misapplication of its discoveries, it is a pleasant contrast to turn to achievements by scientific workers, mainly chemists, which have led to notable contributions to the amenities of modern life

Half a century ago, students of chemistry were impressed by the classical achievements in the synthesis of indigo, just as their predecessors had been inspired by accounts of the synthesis of alizarin and even of the production of artificial ultramarine Just before the First World War, a new trend in synthetic chemistry was revealing itself in attempts to progress beyond the earlier observations on the more or less spontaneous polymerization of isoprene to the preparation of rubber-like products by the forced or controlled polymerization of butadiene hydrocarbons generally In Germany, these researches led to the small-scale manufacture of a new synthetic rubber, which although deficient in the more lively qualities of natural rubber nevertheless yielded a serviceable ebonite on appropriate vulcanization

Later, advances came more rapidly with discovery that the properties of the polymerized product could be improved by modifying the molecular structure of the monomeric butadiene (for example, by using chlorobutadiene or chloroprene instead of the simple butadiene), or by 'copolymerization' of the butadiene with a second unsaturated compound, or by effecting polymerization of the 'monomers' in emulsion or in solution By these modifications of procedure, synthetic rubbers were obtained of such improved quality that they attained commercial importance Moreover, the new technique enabled the synthetic chemist to enhance the qualities of the product in selected directions so that an assortment of 'rubbers' with specific advantages for an appropriate range of special uses became available Thus arose the manufacture of such well-known new types of 'rubber' as neoprene, 'butyl rubber' and the bunas

Concurrently with these advances there came rapid progress in the field of synthetic thermoplastic products This term comprises two types of materials, namely, those made by chemical treatment of high-molecular products provided by Nature and those in which the macromolecules are formed by chemical processes from substances of low molecular weight Typical examples of these two groups are cellulose nitrate, or celluloid, and the phenol-formaldehyde 'resins' Both these developments have involved systematic and detailed investigations into the preparation of possible new materials for eventual transformation into desired elastomers and plastomers, elucidation of the molecular-structural features of these two groups of products, discovery of means whereby the physical and mechanical characteristics of either group may be modified as desired, and elaboration of methods for making the most effective use of the products whether for conversion into moulded articles, sheeted material, filaments or fibres

It is the aim of No 1 and No 3 of the Elsevier's Polymer Series of publications to give a general description of the fundamental background of the chemical and physical factors in the preparation and use of polymeric materials for manufacturing purposes In No 1, "Fundamentals of Synthetic Polymer Technology", which is a revised edition of the book previously published with the title "Technology of Synthetic Polymers", Dr R Houwink has primarily in view the requirements of university students The subject-matter includes the molecular and colloid chemistry of polymers, their more important mechanical and physical properties and methods of testing these, and their general processing, followed by an account of the manufacture and outstanding properties of industrial products of this type, whether obtained by chemical treatment of natural colloidal products or by synthesis from non-colloid raw materials This book has the advantages of single authorship and of revision from the previous edition The English is generally good, although occasionally a little awkward, and author and subject indexes are provided , the rendering of proper names is more accurate than in many books of this class There is a notable freedom from misprints or errors , among the few to be encountered are the description of ethylene dichloride as dichloroethylene (p 23), and the classification of 'Plioform' (p 232) as a cyclized derivative of natural rubber of the same type as 'Vulcalock' No mention is made, as such, of the class of product derivable from natural rubber by treatment with stannic chloride , but stannic chloride is erroneously indicated (p 188) instead of sulphur chloride as the agent for the manufacture, from unsaturated fatty oils, of the rubber substitute known as white factis

In No 3 of the Series, "Elastomers and Plastomers their Chemistry, Physics and Technology", the ground covered is similar , but the treatment is much fuller and is extended to include also some natural products such as natural resins and asphalts, so that No 3 is made up of Vols 1, 2 and 3 on "General Theory", "Manufacture, Properties and Applications" and "Testing and Analysis Tabulation of Properties", respectively The three volumes of No 3 are edited by Dr Houwink and contain altogether some twenty-five chapters contributed by thirty experts representative of Great Britain, France, Holland, Switzerland and the United States One result of this diversity of authorship, which might have been obviated by thorough editing, is an inconsistency in terminology and also in spelling Some overlapping in the matter of various chapters is scarcely surprising , but there are indications of some haste in the editing According to the table of contents as given on the dust cover of each of the three constituent volumes, Vol 1 should include a prefatory statement by Dr Houwink, but this preface has been omitted without comment However, it seems evident that it was intended to explain the aims of this publication on "Elastomers and Plastomers", which provides a reference book for the technologist and research worker in this rapidly growing field of applied chemistry and physics

In Vol 1, C Koningsberger (Holland) contributes a chapter on the organic chemistry of the various types of macromolecular compounds and their synthesis, a chapter follows, by H Wechsler, W P Hohenstein and H Mark (United States), dealing with the kinetics and mechanism of polymerization- (and copolymerization-) reactions and of 'poly-condensations' G J van Amerongen (Holland) then contributes four chapters discussing respectively the molecular and colloidal constitution of high-polymers, the characteristic mechanical properties of these high-molecular colloids and the influence of temperature on elasticity, and the structure of elastomers and plastomers as revealed by methods based on X-ray patterns, birefringence, and the infra-red, ultra-violet and Raman spectra, which is followed by a theoretical consideration of their permeability behaviour to gases and liquids and of their thermal conductivity, and the swelling and solubility behaviour towards liquids, the characteristics of the solutions and their application to determination of the magnitude and distribution of molecular weight in such polymers L Hartshorn (Great Britain) provides a chapter on the electrical properties of plastics and elastics, and R S Colborne (Great Britain) one on the theory of action of plasticizers and on their use In view of the sub-title "General Theory" it is rather unexpected to find the further inclusion of an opening statistical chapter to Vol 1, by H A Frank (Holland), on the economics of the plastics industry with respect to production, and another chapter, by H Gibello (France), on the mechanical operations involved in the manufacture of various types of finished product

In Vol 2 of No 3 the various authors deal with the "Manufacture, Properties and Applications" of the separate groups of elastomers and plastomers Dr Houwink, with the assistance of C P A Kappelmeier (also of Holland) on resins for varnishes and lacquers, deals with the prominent class of phenol-formaldehyde plastomers, A van Royen (Holland) with ion exchangers based on synthetic resins, G Widmer and K Frey (Switzerland) with the urea and melamine resins, H T Neher (United States) with polymers derived from ethylene and ethylenic compounds, for example, the vinyl, allyl and acrylic polymers as well as polystyrene, V E Yarsley, H Kitchen and W J Grant (Great Britain) with the esters (organic and inorganic) and ethers of cellulose, and the various rayon fibres, giving incidentally an account of the fundamental structure of cellulose itself and of methods of analysis for cellulose plastics, A D Whitehead and S H Pinner (Great Britain) with protein plastics, and C Diamond (Great Britain) with synthetic fibres from proteins Synthetic polyamides (for example, nylon), silicone polymers, alkyd resins and natural resins (and their derivatives) are handled respectively by L F Salisbury, J R Elliott, J R Patterson and I C Clare (all of the United States) Chemical derivatives of natural rubber, for example, cyclized, oxidized, chlorinated and hydrochlorinated products are described by T R Dawson, and synthetic rubbers by W J S Naunton (both of Great Britain) A section on asphalts by R N Traxler (United States) ends this volume

Vol 3 of "Elastomers and Plastomers", sub-titled "Testing and Analysis Tabulation of Properties", is in five chapters A very short introductory chapter by Dr Houwink is succeeded by one by J H Teeple (United States) reviewing methods for testing moulding qualities and various mechanical or physical properties of the shaped materials and the influence of external conditions on the test results, the amount of detail is rather uneven A chapter then follows by A G Epprecht (Switzerland) on the chemical analysis of polymers covering tests for detecting various elements, phenols, methyl and ethyl alcohol, phthalic acid, nitrate groups (here described as nitro groups), glycerol and other likely combined constituents of plastic materials A tentative scheme of systematic qualitative analysis for plastics generally is then given, but, in view of the fact that commercial plastics are not likely to be chemically pure, such a scheme would need to be followed with care and considerable critical judgment, a similar comment applies with respect to specific tests for various individual plastics based on flame tests, specific gravity, saponification number, etc Indeed, some of the material of this chapter, especially the tabulation of the resistance of various polymers to a long list of chemical agents including aqueous solutions, appears to indicate some hurriedness of preparation which, indeed, would accord with the survival of the sentence (p 73) "This test is used to determine which ester an acid, possibly present, may exist as" A chapter follows on the quantitative analysis of individual polymers such as the various cellulose esters and ethers, polyvinyl compounds, etc, but again, uncritical compiling or inadequate editing is suggested by the intrusion of qualitative tests some of which have received consideration, quite appropriately, in an earlier section, while others, for example, chlorinated diphenyl and chlorinated naphthalene, might be considered out of place also for other reasons Almost one third of Vol 3 is devoted to tabulations of properties of elastomers, by B B S T Boonstra (Holland), and of plastomers, by J W F van't Wout and R Houwink (Holland) Collections of such data on mechanical and electrical properties, etc, are of limited value, particularly for colloidal materials

In "Elastomers and Plastomers" it is probable that Vol 1 on "General Theory" will appeal more strongly to research workers, whereas Vol 2 on "Manufacture, Properties and Applications" will be more helpful generally to the technologist and manufacturer The selection of writers has ensured authoritative accounts of the different subjects and a wide outlook, but inevitably it has provided much scope for editorial alignments, some opportunities for which have survived for attention in a second edition which, for Vols 1 and 2 at least, is almost certain to be needed The class of materials discussed in No 3 is, as indicated by the title, elastomers and plastomers, but elsewhere in the volumes is described as plastics and elastomers, plastics and elastics (in No 1), and even simply as plastics

Some of the terms which appear in alternative forms at the preference of different contributors are sulphur and sulfur, inflammable, flammable and flamable, ethyl cellulose and ethylcellulose, methyl alcohol and methanol, polythene, polyethylene and polyethene, alkyds, alkydals and glyptals, urea resins and carbamide moulding compounds, benzoyl peroxide and dibenzoyl peroxide, micelles, micells, micellie, micellæ and micelli, Novolacs, Novolaks and Novolacks, Koresin, Korosin and Korosine Such inconsistencies are regrettable because valuable and comprehensive publications such as these could help much towards standardization of terminology in a field where there is already some tendency to laxity, for example, in the indiscriminate use of the terms 'curing' and 'vulcanization' and in the omission of the prefix 'poly-' from the name of a monomer when speaking of the polymerized substance The checking of chemical names in the individual chapters appears to have been carefully done, but attention may be directed to trimethylpropane (presumably for trimethylol propane) and hexamethylene (for hexamethylene tetramine) in Vol 2 (pp 476 and 37 respectively) Simple misprints, however, are not infrequent Each of the three volumes of "Elastomers and Plastomers" is illustrated and has its own subject index, but there is no author index

The importance of industrial plastics is so great and has increased, and is still increasing, so rapidly that the attempt in these books to co-ordinate the available information and to give a constructive review of world-wide research results and theories is praiseworthy and of great potential benefit and assistance to scientific and technical workers in this field and also to students Furthermore, the record of problems encountered and systematically solved will provide a fascinating insight for many who have a general interest in the achievements of modern science

D F Twiss

## CHEMISTRY, ANCIENT AND MODERN

### Crucibles

The Story of Chemistry from Ancient Alchemy to Nuclear Fission By Bernard Jaffe New edition, revised and enlarged Pp xiii + 480 (London Hutchinson's Scientific and Technical Publications, 1949) 18*s* net

WHEN "Crucibles" first appeared in 1930, it quickly achieved wide popularity, particularly in the United States Bernard Jaffe, the author, received the Francis Bacon Award for the "Humanizing of Knowledge", and the book was reprinted several times In the present edition, which is the third, the original text has been revised, and augmented by the addition of material describing recent advances in the study of the atomic nucleus Apart from the final chapters on the development of nuclear studies, the original, biographical, mode of treatment has been preserved throughout The story of chemistry is presented in terms of the work and discoveries of historically important chemists, enlivened by the background of their personal histories

Mr Jaffe's knowledge of the history of chemistry and of chemists is extensive, though one or two errors may be detected where he deals with borderline topics The Watt engine, for example, is described (p 410) as being the first successful steam engine, but the Newcomen engine was at work in the coal pits and tin mines some half a century before Watt brought out his patent However, from a historian's point of view, the main defect of the book lies in its biographical method of treatment We are presented with a succession of chemists rather than with the development of chemistry, and so the discoveries of the individual in some cases seem arbitrary and unrelated to the connected historical development of chemistry itself In a sense, the development of science has always transcended the individual worker, and this becomes more evident, if not more true, the nearer we approach to the present day Thus, in the final chapters of "Crucibles", Mr Jaffe of necessity has placed less emphasis upon the biographical approach and treats the development of nuclear chemistry more as an organic whole, bound together by the logic of inference and experiment

Biographies, however, provide much more detail of human interest than austere analytical works, and in this "Crucibles" excels, ranging over such topics as the usefulness of Dalton's colour-blindness and the content of Kekulé's dreams It is a most readable work, for Mr Jaffe has an eye for quaint detail and a style that is fast-moving, though sometimes rather sensational

S F Mason

## HEAT TRANSFERENCE

### An Introduction to Heat Transfer

By M Fishenden and Prof O A Saunders Pp x+206 (Oxford Clarendon Press, London Oxford University Press, 1950) 15*s* net

THIS concise account of the science and practice of heat transfer has been written to meet the needs of university students of engineering When it is remembered that many of the simplest laboratory experiments on heat transfer involve some very difficult theory for even a partial explanation, it will be realized that the large-scale problems of engineering and industry are only tractable by the use of approximations of sufficient accuracy for the job in hand This kind of work, above all, requires a firm grounding in fundamental physical principles, and the purpose of this book is to guide the reader in relating a large number of practical problems to these principles, as the first step towards their solution The numerical examples worked out in the text form valuable illustrations of the general plan of campaign

In the chapter on radiation, the black-body laws are adapted to practical cases, and tables of data for the emission and absorption of radiation by flames, furnace gases, ammonia and other gases are given The straightforward work on steady-state conduction is followed by an interesting geometrical method of calculating the rate of rise of temperature at any point before the steady state is reached, and examples on this method are worked out The dimensional treatment of both free and forced convection is fully explained, and, in the chapter on forced convection, there is a detailed study of banks and nests of pipes, with appropriate tables of figures There are also chapters on friction in its relation to convection transfer, and on the transfer of heat from a condensing vapour and to a boiling liquid

When Fishenden and Saunders's "Calculation of Heat Transmission" appeared in 1932, it was reviewed in these columns as an important book, by which the authors had placed workers in the field of heat very heavily in their debt Students will surely feel the same about this present volume, which is excellent to read and is directed to their needs with distinguished skill and great experience The development and growing importance of the subject during the past twenty years or so is evidenced by the range of titles and dates of the papers listed in the bibliographies at the ends of the several chapters

G R Noakes

### A Text-book on Crystal Physics

By Dr W A Wooster Reprinted, with corrections Pp xxii+295 (Cambridge At the University Press, 1949) 21*s* net

THIS book still remains the only British textbook entirely devoted to crystal physics It can also claim the merit of being the first to be written with a clear understanding of the relationship between the physical properties of crystals and their atomic structure This appears to advantage in the treatment of the relations between structure types and optical properties Interest in the experimental work is particularly well conveyed by the author, who has been largely responsible for the excellent laboratory course of crystal physics in the University of Cambridge He has incorporated the essential principles of Voigt's standard treatise and achieves considerable condensation of the essential mathematics by the use of tensor notation

It is assumed from the outset that the university student to whom the book is addressed has mastered the elements of physics and crystallography, so that his knowledge of mathematics includes vectorial algebra and can be readily extended to co-ordinate geometry and Cartesian tensors Even so, the brevity of the more difficult passages gives the impression that they are intended to supplement a course of lectures conscientiously attended It is to be hoped that a new edition will seek a happier solution of how to present the necessary mathematical equipment Further chapters on the magnetic properties of crystals, on ferro-electrics and the physical problems of crystal growth are topics which the author may also be tempted to include, if only on account of their possible application to industry

F A BANNISTER

### Fertility and Hatchability of Chicken and Turkey Eggs

Edited by Lewis W Taylor Pp xi+423 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1949) 40*s* net

IT is rather unusual for so many experts to take a hand in the production of a book of the kind under review This should make it much more valuable Dr Taylor has been instrumental in securing the services of nine of America's leading experts in their own particular sphere

At first glance the book gives one the impression that it is 'dry' and not easily understood, but, as one dips into its pages, each chapter becomes more fascinating and exceedingly helpful to those concerned with the problems dealt with While admitting that there are certain pages in the book which are of a technical nature, a large amount of the material can be understood by the average layman Nevertheless, it undoubtedly is a book for the teacher and student, and I should imagine that it will find a place on many library bookshelves

It is difficult to refer to any particular chapter, because all are well written, and the matter equally well arranged There is no doubt, however, that Chapter 6, "Physical Conditions in Incubation", is of great value to the practical man The writer alludes to many important points in connexion with successful incubation, some of which are still doubted by operators

The book is illustrated by a series of excellent photographs It is well printed and the general make-up is very pleasing to the eye There are many reference tables and a good index The glossary puts a finish to a book which is likely to enjoy a good sale It certainly should find a place in all agricultural colleges and farm institutes

H HOWES

### Rinehart Mathematical Tables, Formulas and Curves

Compiled by Prof Harold D Larsen Pp viii+264 (London Chapman and Hall, Ltd, 1949) 15*s* net

THIS book, as its title suggests, contains much information not normally included in a book of mathematical tables, and, although there are volumes in existence in which tabular material is supplemented by lists of formulæ, the latter usually occupy a few pages at most, and do not form a main part of the work

In this case, 160 pages of tables are provided, leaving a further hundred pages for the formulæ and curves The selection of the contents (to quote the preface) is based on a survey specifically carried out in order to determine which tables and formulæ are most frequently needed for use in mathematics, engineering and physics Part 1 contains the usual tables of logarithms, trigonometrical functions, exponential functions, etc, to five-figure accuracy, and also some statistical information, nowadays of increasing importance It would be impossible in the space of a short review to list in detail the contents of Part 2, which are wide and varied In particular, there are forty-three derivatives, 430 indefinite integrals and sixty-four definite integrals, fifty-two series, and about eighty diagrams of well-known mathematical curves

The book is well bound, and the general arrangement and the quality of the reproduction are most commendable

J H PEARCE

### British Fishing-Boats and Coastal Craft

Part 1 Historical Survey By E W White Pp 54 + 20 plates (London H M Stationery Office, 1950) 2*s* net

THE first impression given by this catalogue is that it is just a paraphrase of the earlier work, "British Fishing and Coastal Craft", by the late Mr G S Laird Clowes This is unfortunate, for it conceals much useful new material which has been put into it I feel that it could have been re-cast in such a way as to do more justice to both authors This is only a very minor grumble The catalogue is a most valuable work at a most reasonable price

There are some small points which might be given more consideration in a future edition First, I do not feel that enough attention has been paid to Captain H Lovegrove's article in the *Mariner's Mirror*, which appears to give a clear picture of lute sterns on the Sussex coast in Elizabethan times Secondly, William Daniell's prints show many illustrations of Scottish fishing boats on the west coast of Scotland in the early nineteenth century which could be consulted with advantage Double-ended decked smacks, Norse-type open boats rigged as two-masted luggers, and large cutters are all in evidence Finally, if it was necessary to cite the testimony of Julius Cæsar three times to prove the existence of early curraghs, use might have been made of the Massiliote "Periplus" to show that they were employed in the tin trade with Brittany five hundred years earlier.

T C. LETHBRIDGE

## Popular Fallacies

A Book of Common Errors, Explained and Corrected with Copious References to Authorities By A S E Ackermann Fourth edition Pp xv+843 (London Simpkin Marshall, Ltd , 1950 ) 30*s* net

It is almost exactly twenty-seven years since the third edition of this well-known work of reference was published, and in his preface the author states that eight hundred additional fallacies have been dealt with, an increase of some 60 per cent on the number included earlier He adds, rather frighteningly, that he has still some 1,150 probable fallacies on his card index but "insufficient evidence by which to convict them" This statement gives a fair indication of the meticulous care with which Mr Ackermann weighs the arguments before he demolishes any one of our cherished illusions

The field covered by the book is very wide, and the reader will indeed be well informed if he cannot associate himself with Sir Richard Gregory's remark in the introduction that he has "derived both pleasure and profit from excursions into all its parts" He will need, too, to be made of sterner stuff than the reviewer if, after reading with some self-satisfaction an exposure of a fallacy to which he has long since ceased to subscribe, his eye is not caught by another, less familiar, and then another and so on until, before he realizes what has happened, the hours have flown and he has become a wiser man than when he started his perusal A good book is furnished with a good index

## Modern Methods for the Analysis of Aluminium Alloys

By a Committee of Chemists convened by ALAR (the Association of Light Alloy Refiners) Editors G H Osborn and W Stross Pp vii+144 (London Chapman and Hall, Ltd , 1949 ) 13*s* 6*d* net

This book is the outcome of the work of a committee of chemists of a group of firms specializing in the refining of secondary aluminium, and, in the belief that the results would be of wider interest, these have here been published In addition to volumetric and gravimetric methods, photometric, electrolytic and polarographic processes, now firmly established, are well described Spectroscopic methods, though widely employed, have been excluded on the ground that this field would require a book to itself The important, but sometimes neglected, subject of the sampling of the material is given special attention To all concerned with the analysis of aluminium alloys this book can be strongly recommended

## Proceedings of the Second Rubber Technology Conference held under the Auspices of the Institution of the Rubber Industry on June 23–25, 1948, at the Central Hall, Westminster, London, S W I

Edited by T R Dawson with the assistance of C M Blow and G Gee Pp xxxii+523 (Cambridge W Heffer and Sons, Ltd , 1949 ) 63*s* net

The issue of the collected papers contributed to the 1948 Conference on Rubber Technology (reported in *Nature*, 162, 204; 1948) provides a convenient reference book covering a wide range of topics connected with the science and technology of rubber. The papers are arranged under the following sectional headings synthetic rubbers, chemistry of rubber, physics of rubber, testing and analysis, latices, compounding ingredients, factory processes and products The intrinsic value of the papers is enhanced by the high quality of the printing and binding, and of the editorial work and general arrangement Papers are followed by summaries of the discussions which took place at the meeting, and a report of the discussion on tensile strength, hardness, abrasion and tear testing is included

L R G Treloar

## Modern Science and its Philosophy

By Philipp Frank Pp ix+324 (Cambridge, Mass Harvard University Press, London Oxford University Press, 1949 ) 36*s* net

The author of this collection of essays is one of the original members of the group of thinkers afterwards known as the Vienna Circle, and he is here expounding its logical positivism or logical empiricism. The introductory chapter contains an interesting account of the development of the group and the derivation of its ideas from the work of Ernst Mach, Henri Poincaré, and a less-known French writer, Abel Rey The exposition of Mach's philosophy in the early chapters is also worth having. Several chapters are controversial Prof P Frank's way of dealing with points of view other than his own is to attach derogatory labels, such as 'Kantian' or 'idealist', and then dismiss them This follows from his belief that there is only 'scientific truth' which is genuine (though purely phenomenal), and that all philosophies except his own consist of claims to some other kind of sham truth In consequence, he is considerably embarrassed by the Marxists, who make the same claim for their own philosophy, and dismiss his by his own method as 'idealist' The author's positive exposition of his own views is far from clear He appears to think that pragmatists and Bridgman in his 'operational theory' are saying just about the same thing as phenomenalists

A D R

## Introduction to Atomic Physics

By Prof S Tolansky Third edition Pp xi+371+5 plates (London, New York and Toronto Longmans, Green and Co , Ltd , 1949 ) 15*s* net.

This new edition of Prof Tolansky's book can be recommended with confidence It contains a well-balanced account, suitable for second- and third-year students, of the fundamental aspects of atomic and nuclear physics and of many interesting applications of these subjects

There are some minor criticisms one may offer Occasionally too much detail is given, which tends to obscure the more basic aspects of an account Sometimes, to go to the other extreme, over-simplification leads to some ambiguous statements and even errors For example, the idea of stopping-power, discussed very briefly on pp 242–243, gives the impression that the stopping-power of *any* sheet of material is proportional to the square root of the atomic weight, Prof Tolansky means, of course, the atomic stopping-power One section which might be re-written and brought up to date is that on pp 235–237, on the detection of single α-particles (It might also be extended to include the detection of other particles )

However, despite these blemishes, this is much the best book published in Great Britain for introducing atomic and nuclear physics to science students.

J. D.

# HIGH-ENERGY PARTICLES AND MACHINES FOR THEIR ACCELERATION

A GROUP of papers on high-energy particles and machines for their acceleration was arranged by Section A (Mathematics and Physics) of the British Association, and presented at Birmingham on August 31 In opening the session, Prof R E Peierls said that our interest in fast particles arises from the fact that we wish to learn more about the nature of the forces occurring in the atomic nucleus In the past fifty years, the fundamental laws governing atomic structure have been well established The experimental data upon which they are based was obtained by a careful study of the interaction between electromagnetic waves of suitable wave-lengths, that is, light and X-rays and the internal electric fields of the atom The refinements introduced by the quantum theory were necessary to take account of the small distances over which these electric fields are acting

To establish the nature of the forces within the nucleus a similar study is necessary, but the important difference arises that these forces are known to be not electric in nature They are much stronger than electric forces and act over shorter distances, the nucleus being of the order of $10^5$ times smaller than the atom To react strongly with these forces, bombarding projectiles of very high energies are necessary For example, with more energetic particles than are yet available, we may hope to produce in the laboratory a meson heavier than the $\pi$-meson There is some evidence for this particle in cosmic ray work At about three times the highest energy yet achieved, negative protons may also be expected They should occur in a similar way to the creation of positive and negative electrons by the interaction of electric fields In addition, we must never overlook the possibility of new events occurring about which we know nothing at present

Mr D W Fry described recent progress with the travelling-wave linear accelerator method for producing high-energy electrons The method employs the $E_0$-type electromagnetic wave, which may be built up in a cylindrical metal tube loaded with metal corrugations The velocity of the wave and electrons injected into it may be made to remain in step as they travel along the accelerating tube Radial defocusing fields may be overcome by applying a steady axial magnetic field With an accelerator built at Malvern using a peak power of 2 MW in 2-μsec pulses on a wave-length of 10 cm, electrons were accelerated to 3 8 MeV in a distance of 2 metres The maximum accelerated pulse current was 300 m amp. It is now being used at Harwell to generate a pulsed source of neutrons by the action of gamma-rays on beryllium Neutrons of energies up to 1 keV are available to study the properties of materials A 15-MeV accelerator to provide an even larger flux of high-energy neutrons is now being made The main characteristics of a 10-MeV machine being built for the Medical Research Council in Messrs Metropolitan-Vickers Laboratories were also outlined Mr Fry said that the production of 1,000-MeV electrons by a linear accelerator is now being considered Theoretical studies by Mr Harvie and his colleagues show that the power required to accelerate electrons to this energy might be reduced substantially by using wave-guides suitably loaded with low-loss high-permittivity ceramic disks instead of the copper diaphragms used so far Experimental work upon these new types of wave-guide has been started

Dr L U Hibbard then described the University of Birmingham 1,000-MeV proton synchrotron It is a cyclic accelerator in which the particles travel around a toroidal-shaped vacuum chamber at an approximately constant radius This chamber is placed between the poles of an A C magnet, acceleration taking place when the magnetic guiding field threading the annulus is increasing A radio-frequency field is produced within the annulus by a C-shaped electrode, and the energy of the particles increases if they pass through this field at a suitable phase Automatic synchronism between the particles and the radio-frequency field is maintained so long as the radio-frequency is suitably adjusted with increasing magnetic field In the Birmingham machine the orbit radius is 450 cm The magnetic field in the annulus rises to a maximum value of 15,000 gauss in one second The radio-frequency accelerating voltage will be 240 volts r m s produced between the ends of a C-shaped electrode stretching 130° around the annulus and an outer electrode at earth potential Protons will be injected at 0 5 MeV and the radio-frequency changed from 800 kc /s to 30 Mc /s during the acceleration of the particles The magnet construction, excitation and cooling were described To prevent an excessive loss of particles in the early stages by gas scattering, phase oscillations and other causes, the radio-frequency and the magnetic field must be accurately related Also the working gas pressure must be not greater than $10^{-6}$ mm of mercury The steps being taken to meet these requirements were described

Experiments using the 25-MeV electron synchrotron at the Atomic Energy Research Establishment, Harwell, were discussed by Mr F K Goward Nuclear emulsions have been irradiated with the gamma-ray beam and the nuclear explosions producing three- and four-pronged stars examined. The three-pronged stars are found to be the disintegration products of carbon nuclei, the four-pronged ones are of oxygen nuclei With carbon photodisintegration it is found that one alpha-particle is first emitted, leaving a beryllium-8 nucleus which then disintegrates into two alpha-particles The beryllium-8 nucleus may be left in either the ground-state or an excited level Goward and Wilkins have found that a large fraction of the observed events pass through the 3-MeV level, but some pass through the ground-state This latter condition had not been previously reported The cross-section versus energy for the reaction has been measured, it shows a sharp fall above 18 MeV This may be due to competitive processes, in particular the $(\gamma, n)$ reaction In the oxygen disintegration, it is found that the predominant mode of disintegration is via the 9 7-MeV. excited level of carbon-12 and not by initial splitting into two beryllium-8 atoms The carbon-12 in turn splits into beryllium-8 nuclei, which then disintegrate into two alpha-particles. Mr. Goward believes that the importance of these experiments lies in the information which they should provide for checking up the alpha-particle model of nuclear structure and the advances in nuclear techniques which are being made in these studies.

Experiments with the frequency-modulated cyclotron at Harwell were described by Dr. T. G. Pickavance. This machine, which first operated in December 1949, makes use of the principle of phase-stable particle orbits, described independently by Veksler and McMillan in 1945. It is designed to accelerate protons to a maximum energy of 175 MeV. The magnet poles are 110 in. in diameter and its power consumption 350 kW. for a central field of 16,000 gauss. The accelerated mean beam current is 1·5 microamp.

The first experiments carried out have been the measurement of total collision cross-section of high-energy neutrons in hydrogen. A well-collimated neutron beam, produced by the 171-MeV. proton beam falling on an internal beryllium target, was detected by counting recoil protons from a polythene disk in the beam with a triple-coincidence telescope of three proportional counters. Absorbers in the telescope limited the effective energy of the detectable neutrons to 156 MeV. The beam intensity was compared with and without attenuating rods of polythene and carbon in it. The measured total cross-section was $4 \cdot 64 \pm 0 \cdot 12 \times 10^{-26}$ cm.$^2$.

The energy spectra of neutrons ejected from beryllium, carbon and aluminium targets have also been measured and were shown. A triple-coincidence telescope was again used, the third counter being replaced with an ionization chamber gated to count protons over only a limited energy range. The energy spectrum was measured as a function of absorber thickness between counters for both polythene and carbon radiators. The transparency of beryllium, carbon and aluminium was found to decrease in that order; so also did the yield of high-energy neutrons.

Prof. P. M. S. Blackett concluded the session by describing evidence from cloud-chamber studies of cosmic ray showers for the existence of two new particles. In December 1947, Rochester and Butler published two cloud-chamber photographs containing forked tracks of a striking character. It was their opinion that one of the forked tracks represented the spontaneous transformation in the gas of the cloud chamber of a new type of uncharged particle into two lighter charged particles, and the other the transformation of a new type of charged particle into two light particles, one of which was charged and the other uncharged. The apparatus has since been taken to the top of the Pic du Midi, where the probability of finding further similar events should be increased by eighteen to twenty times. Six V-tracks have been found in the past two months. Prof. Blackett said he had also heard from Dr. C. Anderson of Pasadena that he has found thirty-four events having similar characteristics. Of Anderson's events, thirty may be interpreted as a neutral particle disintegrating into a positive and a negative particle, and four as a charged particle going to a lighter charged particle and a neutral one.

From preliminary analyses of the Pic du Midi photographs, it seems probable that the lighter particles are $\pi$-mesons, so that the disintegrations might be of the form:

$$V_0 \rightarrow \pi_+ + \pi_- \quad \text{or} \quad V_\pm \rightarrow \pi_\pm + \pi_0.$$

The energy of the new particle is in the region of $10^9$ electron volts, and Butler's preliminary estimate of the mass of his $\pi$-mesons, 700–800, makes it rather lower than the present generally accepted figure. One photograph obtained might be open to interpretation as a double $V$-decay, but further evidence is required.

D. W. FRY

# FINGER PRINTS AND DISEASE

## By F. R. CHERRILL

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As a result of examination of the hands of decomposed cadavers over a long period, it has been noticed that as a rule the muscles and skin of the left hand exhibit signs of greater decomposition than the right. This may be explained by the fact that the muscles, tendons, aponeuroses, etc., are less developed in the left hand than in the right, and would, therefore, less effectively withstand the ravages of the elements.

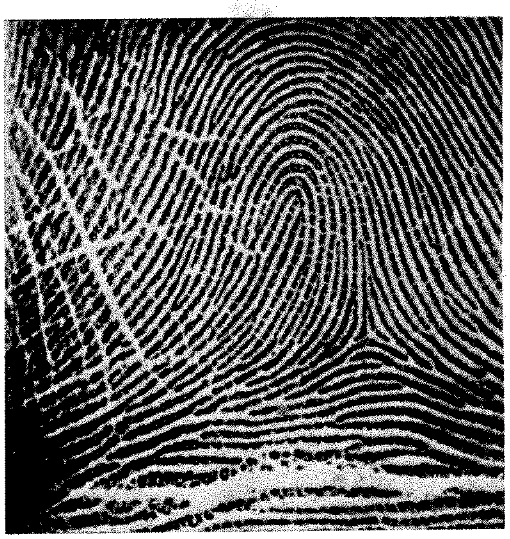

Fig. 1

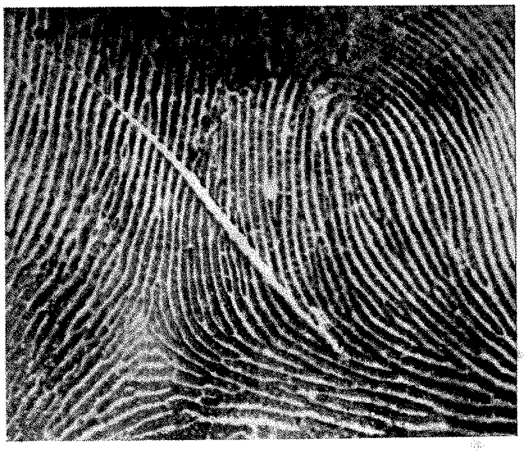

Fig. 2

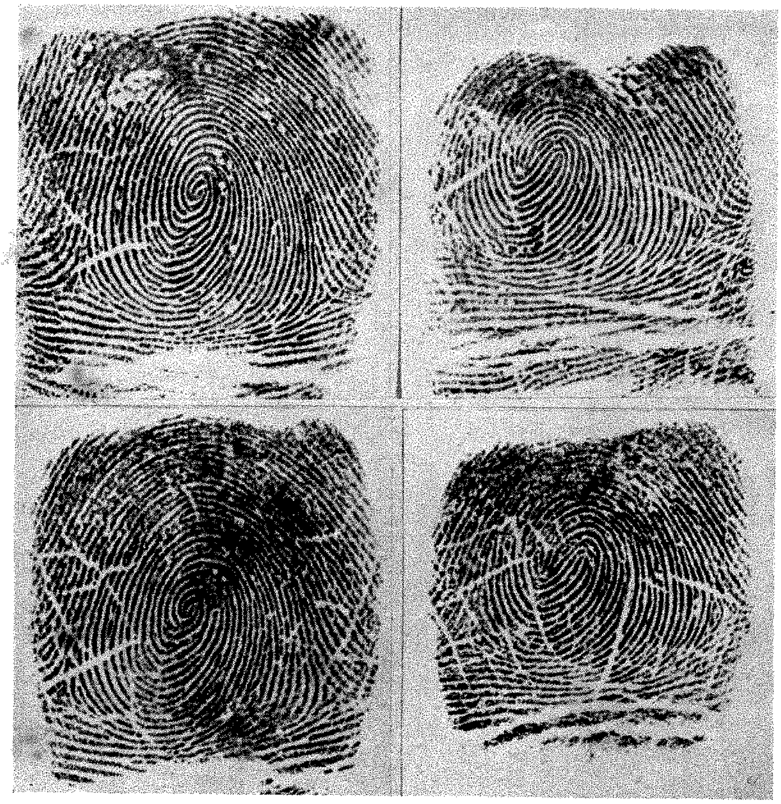

Fig. 3

**Impression of left ring finger taken: top, on Nov. 8, 1946; bottom, on Nov. 12, 1948**

**Impression of left little finger taken: top, on Nov. 8, 1946; bottom, on Nov. 12, 1948**

There may be other causes for the more rapid decomposition of the left hand; but it would need confirmation by the examination of the decomposed hands of left-handed persons and of the ambidextrous. Unfortunately, it is difficult to obtain reliable data for this purpose.

Since the left hand appears to be more susceptible to change under post-mortem conditions than the right, it was thought that the left hand of a living person might show certain signs indicative of disease, or even the approach of disease. A study of finger prints of persons suffering from certain pathological conditions lends some support to this contention.

A finger print is a picture of the papillary ridges on the distal phalanx of a finger or thumb which is obtained by inking the crests of the ridges. The immutability of the papillary ridges, which are formed early in fœtal life, is an established fact.

There are, however, other markings which are encountered on the fingers of some persons, and which are not so evident. They are creases which occur in the distal phalanges of the fingers, and cross the paths of the papillary ridges at more or less acute angles. When they are present they appear in finger prints as white lines (Fig. 1).

The white lines are similar in appearance to the scars left after the severing of the papillary ridges by a knife or any other sharp instrument (Fig. 2).

It should be emphasized that the creases under discussion are not of occupational origin but are distinct from wrinkling—the result of immersion, or cracking of the skin arising from contact with weak irritants, such as lime, soda, etc. Experience shows that the skin quickly recovers when such contacts cease; the 'white line' creases, however, though not immutable, are more persistent. It is suggested that there may be some as yet undefined pathological cause for the occurrence of the creases which give rise to the white lines.

When present in finger prints, white lines are ignored for purposes of comparison as they are not permanent features and are known to increase or decrease, both in size and numbers, over given periods. These lines are noticeable in finger prints of babies and sometimes are markedly present in the prints of aged persons; but they are indicative neither of youth nor of age, since they may also be found in prints of persons of all ages.

An examination of a large number of prints of apparently normal persons ranging from the ages of 16–75 years shows that approximately 11–12 per cent disclose these white lines. It has been found that if the white lines are absent in the middle, ring and little fingers of the left hand they are rarely present in the others. They are mostly confined to these three fingers and often to prints of the ring and little fingers only.

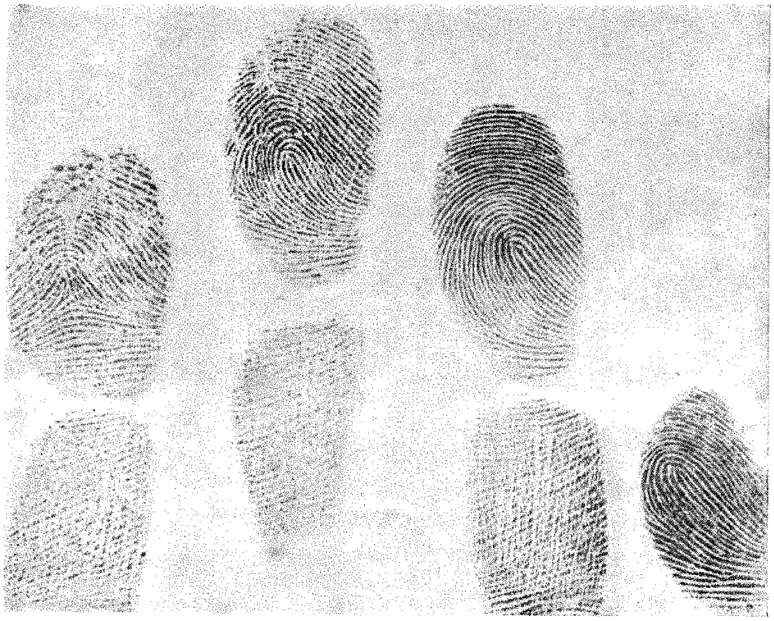

Fig. 4

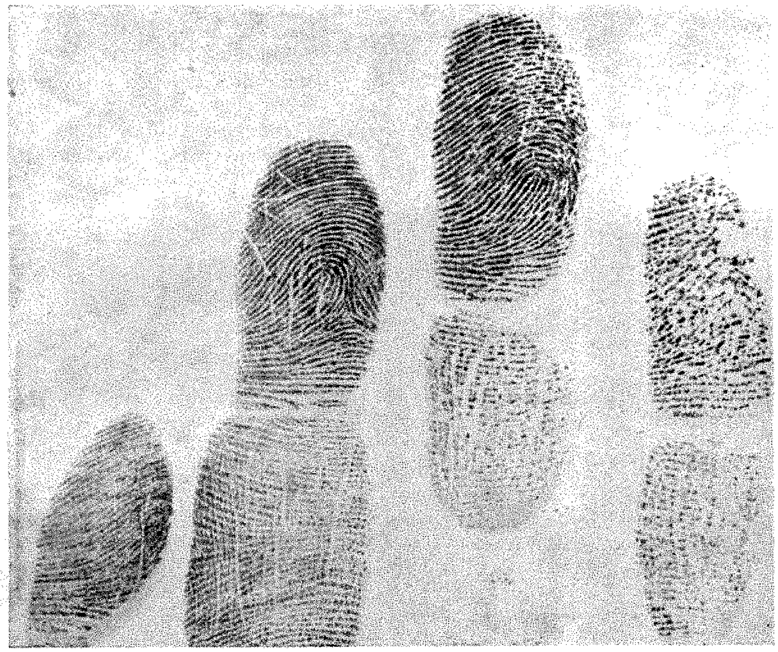

Fig. 5

Whatever the pathogenesis of the white lines under discussion, their variable occurrence in certain pathological conditions and the degree of the lesion may be pathognomonic.

Attached impressions taken of the left ring and little fingers (Fig. 3) on November 8, 1946, of a girl suffering from Darier's disease are compared with those taken on November 12, 1948. During the two intervening years the condition of the skin had clinically deteriorated considerably. It will be observed that the number of white lines present in 1946 had appreciably increased in 1948. On both occasions approximately the same pressure was applied in obtaining the prints. In afflicted persons the 'white lines' appear to be more common on the ring and little fingers of the left hand than on the other digits. They are also more common over the areas supplied by the dorsal cutaneous branch of the ulnar nerve.

This is further illustrated by the finger prints of a medical man suffering from lesions caused by radium. Fig. 4 shows that 'white lines' are almost absent from the prints of the right hand, but are marked in those of the left ring and little fingers, especially on the ulnar side of the ring finger (Fig. 5). The skin of the left forefinger had suffered most damage. It may also be significant that the disruption of the papillary ridges shows some similarity to that noticed in the prints of lepers. White lines have also been observed in the prints of the left ring and left little fingers of epileptics.

That the development of 'white lines' is not due to a biological process, but may continue after death, becomes evident from a comparison of finger prints of a woman aged ninety years, which were taken on two occasions after death. Although white lines were absent from the prints taken on the first occasion, they were very manifest in those of the left ring and left little fingers taken two days later. None was present in any of the prints of the remaining fingers.

In a case of poliomyelitis, the condition of the patient, 17½ years old, precluded satisfactory prints of the left hand being taken; after several attempts, however, prints, limited in area, were obtained. It will be observed that a distinct white line appears in the impression of the ring finger (Fig. 6). Inspection showed that creases were not present in any appreciable degree on the other fingers. Another outstanding feature disclosed by the prints was the abnormal distension of the mouths of the ducts of the sweat glands. The corneous and Malpighian layers of the epidermis also appeared to have atrophied to such an extent that in some areas of the prints two fine ridges replaced a single ridge occurring in a normal print (Fig. 7). This may have been caused by the impingement of the double row of papillæ of the dermis, corresponding to, and located immediately below, a single epidermal ridge. Such a condition is known to appear in finger prints taken of the dermis after the epidermis has been removed. A test of the sweat deposit from the fingers of each hand, obtained through the medium of slides, showed that the epithelium debris was far greater in the case of the right hand than of the left. This is in perfect harmony with the fact that the left hand was affected to a greater extent than the right. The sodium chloride crystals in the sweat deposit were considerably decreased both in size and quantity.

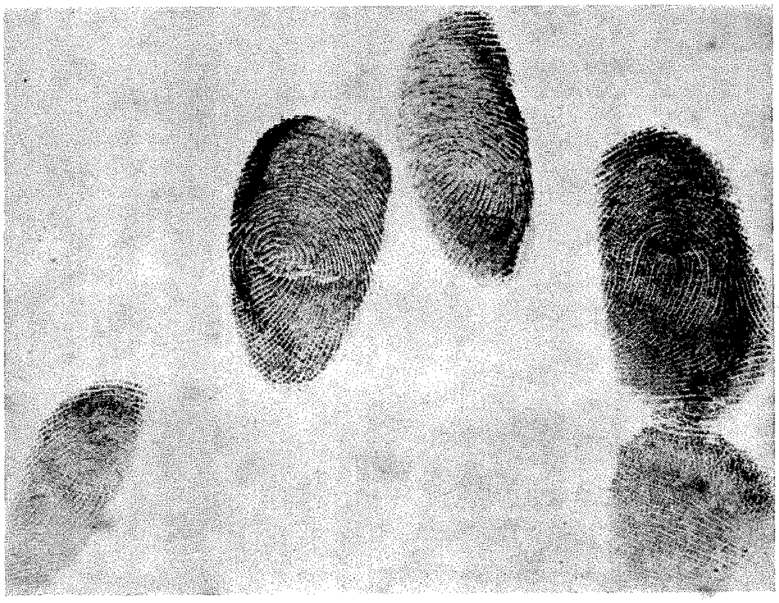

Fig. 6

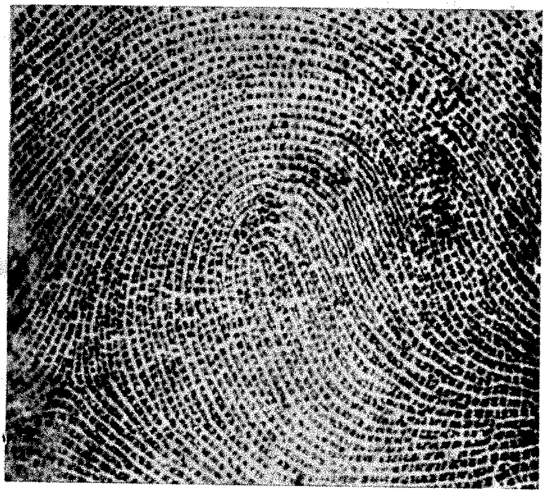

Fig. 7

The finger print test was also applied successfully in a case of congenital ectodermal dysplasia of the anhydrotic type, attributed to the protracted action of fluorine on the pregnant mother[1].

Observation of the prints of a person suffering from a tubercular spine showed that with the progress of the disease the papillary ridges had atrophied to knife-edge dimensions.

Further investigation will be needed before any definite conclusions can be arrived at, but it is suggested that a prolonged scientific analysis of finger prints would, in some cases, supply evidence of incipient disease and of its progress. Owing to the prejudice which still lingers against the taking of finger prints, no matter for what purpose, it is unfortunately not easy to obtain them from the subjects who may prove of interest.

I wish to express my sincere thanks to Dr. W. Howlett Kelleher, physician superintendent of the Western Hospital, Fulham, London, S.W.6, for his assistance and permission to obtain finger prints from a patient under his care, and to Dr. Isaac Jones and Dr. Leo Spira for their helpful advice and interest.

[1] *Acta Med. Scand.*, Stockholm, **127**, 570 (1947).

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# FORESTRY IN WATER CATCHMENT AREAS*

THE necessity for protecting the raw water from pollution in a water-supply catchment area, even with the provision of adequate mechanical filtration, demands close supervision of human activities and land utilization. The report of an official committee appointed in recent years to inquire into this[1] recommended that, subject to the existence of adequate filtration and measures for the disposal of sewage, land in catchment areas should be put to the utmost agricultural use. This recommendation is understandable in view of the considerable acreage of land taken up by water-supply catchment areas and the way in which agricultural land in Great Britain at the present day is being lost to production. At the same time, the factors of the physical landscape—altitude, climate and soil—are often unfavourable for agriculture, and in these instances the committee recommended that the land should be afforested, bearing in mind the requirements of adjacent agriculture.

A recent survey of the progress of afforestation in twenty-eight of the larger water-supply catchment areas in Britain reveals a very dismal picture. In only one is 20 per cent of the area afforested, and thirteen have no land under forest. The factors producing this situation are not hard to find. In a minority of instances, industrial pollution, particularly of the atmosphere, prevents successful growth. The cost of planting and tending the forest, with little immediate return for capital outlay, makes afforestation economically difficult. But the most important retarding factor is the problem of ownership. Only seven of the twenty-eight authorities own the whole of their catchment area, a further five own more than 50 per cent and eight own 20 per cent or less of their land. This lack of ownership prevents the complete control of activities within the catchment area. The Corporation of Birmingham in its catchment area in the Elan Valley has to observe commoners' rights, allowing them to control the surface of the ground but not to break it. The freehold areas that have been afforested in the Elan Valley since 1916 have been a financial loss, caused to a large extent by the depreciation of money values during the period in which the timber has been growing.

Economic difficulties of planting are being overcome by agreements made between water undertakers and the Forestry Commission, the former leasing land for future planting. Where absence of ownership prevents afforestation, there is obvious scope for the Forestry Commission to exercise its right of acquisition in preference to some of the suggested acquisitions of good sheep-farming land which have been made in recent months.

With the progress of afforestation so retarded, it is obvious that it is not yet possible in Great Britain to determine the effect of tree-cover on run-off, flooding, erosion and silting. In any event there is a lamentable lack of accurate and scientific record of stream flow and run-off. In the Lake Vyrnwy catchment area, with 20 per cent afforestation, there is no positive evidence of tree-cover either increasing or decreasing the run-off.

The absence of interest in recording stream-flow and run-off is probably due to the generally 'average' climate conditions in Britain, particularly the relatively few instances of rainfall of high intensity. However, when this does occur—as it did over a wide area in south-east Scotland and north-east England on August 12, 1948—the damage caused can be very considerable and with total costs running into several millions of pounds. Such conditions would certainly not be aggravated, and are far more likely to be alleviated, by the presence of tree-cover. A favourable influence would doubtless be exercised on reservoir silting. This is a long-term process; but in eleven out of the twenty-eight authorities it will become serious in reducing reservoir capacity within the next hundred years. The capacity of Abbeystead reservoir of the Lancaster Corporation has been reduced from 185 million to 100 million gallons since its construction in 1872.

In many of the catchment areas of Britain, peat deposits in the upper parts play an important part in decreasing run-off and maintaining dry-weather

* Substance of a symposium in Section K* (Forestry) of the British Association, held at Birmingham on August 31. Papers were read by R. Mansell Prothero, D. Lloyd, A. T. A. Learmonth and A. E. Fordham.

flow by absorbing rainfall It is necessary to remove peat before planting, and it would have to be considered, if this were done on a large scale, what effect it would have on increasing the run-off before the trees reached a stage of development when they might take over the function formerly fulfilled by the peat

In catchment areas where there is a considerable area of land at more than 1,500 ft and therefore possibly unsuitable for tree-planting, there might be an effective combination of forestry and sheep farming The land above this altitude might be used as summer pasture, the sheep being brought down to lower altitudes in the winter through sheep-walks left in the forest, provided that convenient winter pasture could be found outside the catchment area On the other hand, it has been suggested that flooding on the Rivers Usk and Severn in recent years has been accentuated by increased run-off from the hills due to hill-draining The latter might be necessary for successful sheep-farming in reservoir catchment areas, and its effect in increasing run-off would work in opposition to forest planted to control it

Apart from the general suitability of forest as a form of land use in water-supply catchment areas, there is a need for positive evidence to be collected of its influence on run-off and stream flow and therefore on flooding, erosion and silting Until more forest has been planted and many years have been given to such experiments in order to provide the necessary long-term averages, it will only be possible to make generalized statements and to draw on results and data from other parts of the world, where often environmental conditions and factors at work are very different from those in Great Britain

R M PROTHERO

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[1] Report of the Gathering Grounds Sub-Committee of the Central Advisory Water Committee Gathering Grounds, Public Access, Afforestation and Agriculture (London H M Stationery Office, 1948)

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# PRESENT POSITION OF THE THEORY OF CONTINENTAL DRIFT

IF the size and lively interest of the audience is any measure in such matters, the joint discussion held on September 1 during the recent Birmingham meeting of the British Association between Sections C (Geology), D (Zoology), E (Geography) and K (Botany), on "The Present Position of the Theory of Continental Drift", was a very successful one

The principal contributors numbered eight, namely, Dr J. R F Joyce and Prof J H F Umbgrove on the palæogeographical side, Prof R D'O Good and Dr H E Hinton speaking for the botanists and zoologists respectively, Prof H Jeffreys and Prof S W Wooldridge representing the geophysicists and geomorphologists, and Prof W T Gordon and Dr J B Simpson speaking for the palæontologists Strict attention to time-keeping—that bugbear of conferences—allowed also many comments from among the body of the audience It was disappointing that neither of the first two speakers was present in person, but their communications were read for them

Joint discussions have become a familiar and valuable feature of British Association meetings, and their purpose should not be misunderstood They are seldom the occasion for the announcement of profound scientific discoveries, but serve chiefly as short refresher courses by which men of science of various interests may keep abreast of developments in some of the problems which may not be their own more particular concern, while they give to those most closely associated with them the opportunity of taking stock, of estimating what changes of emphasis are desirable, and of incorporating new ideas It is more especially with these latter points in mind that these few comments on the discussion have been prepared by one of the biologists who took part

The present position of the theory of continental drift can, in outline in any event, be quickly stated It is that while most biologists and palæontologists find in some form of land-surface displacement the best working hypothesis to explain the facts of plant and animal distribution, and therefore tend to favour theories of continental drift, the majority of geophysicists and geologists reject it, not only because of the lack of direct positive evidence, but also because they know of no force capable of producing the required movement This difference of opinion, here expressed in the briefest of terms, seems quite clear-cut, and calls for some consideration

To begin with, there are two possible misconceptions to be cleared away The idea of continental drift first found full expression in Wegener's theory (1912), in which a very definite chronological sequence of events is postulated, and more modern workers have modified this in various respects Those who believe in continental drift need not necessarily, therefore, subscribe to all the details of Wegener, and this is not always fully appreciated Rather similarly with the word 'drift' Ideas formerly rigid have now become more supple, and support for some theory of continental displacement must not be taken to assume belief in exactly the kind of drifting movement suggested by Wegener That there is nothing merely casuistical about these points can be shown by comparing the position of the biologists and geophysicists a little more closely

The position of the biologists is that they are called upon to explain, within the terms of modern evolutionary theory, a great series of facts which, in a single phrase, may be called the remarkable floristic and faunistic relationships between distant countries They find it impossible to believe that these are due to normal or even abnormal dissemination across the intervening spaces, and they are therefore obliged to think that the now sundered lands either were once connected by subaerial surfaces which have disappeared, or were once nearer to one another than they are at present The former involves some theory of land bridges, the latter some theory of continental displacement This is not the place to consider the relative merits of these and it can only be said that few, if any, biogeographers prefer the former to the latter Nearly all, therefore, favour some displacement theory *faute de mieux* If other scientific workers can provide them with a more satisfactory solution of their problems, well and good, but meanwhile the facts remain and have to be accounted for Some biologists go further than this, and, with other protagonists of displacement, believe that the facts of biogeography afford direct evidence that this has taken place

The position of most geophysicists and their co-workers, on the other hand, is that physical evidences and data must carry conclusive weight, and that since according to these evidences there is neither indication nor even possibility of continental drift, the idea cannot be sustained and the biologists must seek elsewhere for their solution

It must be confessed that biologists sometimes find this attitude a little too rigid for their liking, and feel that there is some real difference between the evidence in the two cases They feel that the facts of plant and animal geography have an objectivity and stability greater than those of some beliefs concerning the physical condition of the earth They notice in the latter that the moduli concerned are on occasions modified, and they feel also some misgivings about the completeness of the present picture of conditions deep within the earth On the other hand, no doubt, some geophysicists feel that since biologists are rarely expert mathematicians and physicists enough to appreciate these mysteries, their opinions are of limited value

All this emerged clearly enough from the discussion, but there were also plenty of indications that the cleavage of opinion is really not so fundamental as may appear On one side, the biologists made it plain that they are not committed to the minutiæ of Wegener's theory, on the other hand, the contribution of Prof Umbgrove, for example, showed that while drift in the classic sense may be unacceptable, something in the nature of crystal buckling and contraction may result in comparable degrees of horizontal displacement Similarly, the possibility that vertical rather than horizontal earth movement may be sufficient to bridge some conspicuous gaps, the discussion of the value of 'isthmian links' or stepping stones of island chains, and the suggestion that surer knowledge of the sequence of geological events might itself reduce the number of problems, were all feelers towards the integration which can with some confidence be looked for eventually of now opposing views

There is space left to mention only a few of the many more particular points of interest raised Perhaps the most original contribution was that of Dr Joyce, who accepts the view that South Graham Land and its extension to King Edward VII Land is separated from the main mass of Antarctica by a trough This smaller portion of Antarctica, together with the Scotia Arc of island groups east and south-east of Cape Horn, forms a loop, which when straightened out links up eastward with New Zealand, and forms a bond linking South America, Africa, Antarctica and Australia when these are placed in juxtaposition The Scotia Arc so placed provides the missing fold region for the Antarctic

Another nice point concerned the light relations in polar regions In these highest latitudes, there are long continuous periods of daylight and of darkness, a condition presumably unaffected by secular temperature changes Various fossil plants are known from the Antarctic continent, and the question is whether any of these could have existed under such light conditions as now prevail there The implications of the answer have particular importance with regard to the Antarctic Tertiary flora

Almost inevitably the likelihood of the population of isolated islands by casual methods of dispersal cropped up, and indeed in terms which suggested that the Kon-tiki epic was not the first of its kind, but there was evidently a feeling that to put too much weight on this is to burke the main issue

An early speaker warned his audience against the uncritical use of reported cases of discontinuous distribution, and it was significant that the only instance of plant geography referred to afterwards was just such a case, that of *Cornus*, which has recently been quoted in connexion with continental drift[1] The family of the Cornaceæ is one of the least satisfactory in Angiosperm classification and has suffered a series of dismemberments and revisions Its chief genus *Cornus*, contains several very distinct sections, some of which have been regarded as distinct genera, and the significance of any geographical statements based on its classification can only be regarded as most doubtful

Discontinuity also received attention in the question as to whether the similarity between organisms in places far distant from one another might be due, not to community of origin but to parallel or convergent evolution, a possibility that must always be remembered

Other questions were of a more severely practica sort, and these more than any others betokened what was perhaps the most noteworthy impression left by the discussion, namely, the need for more factua information about certain crucial issues When, to quote but one such issue as an example, we really know of what the floors of the oceans are made, then we may speculate more happily as to how the materia got there

RONALD GOOD

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[1] Longwell, C R, *Amer J Sci*, **242**, 218 (1944)

# OBITUARIES

## Prof H S. Reed

PROF HOWARD SPRAGUE REED, widely known as a botanist, plant physiologist, and since 1935 a member of the faculty of the University of California died at the age of seventy-three on May 12, 1950, in Berkeley, California For many years Dr Reed was associated with the Citrus Experiment Station at Riverside, California, and many visitors to that research station will recall his genial hospitality and keen interest in other people and other problem than his own For the last fifteen years of his life Dr Reed resided at Berkeley, California, where h was associated with the Division of Plant Nutrition of the University of California

To readers of the literature of plant physiology Prof Reed first became well known for his writing on growth and its analysis in mathematical terms Later, his interests turned to cytochemistry, especially in the attempt to trace by its aid the role of th micro-nutrients in the growth of plants Dr Reed' wide scholarly interests, however, were given expression in his historical works, notably "A Shor History of Plant Sciences", published in 1942, an still more recently an appreciation of the work o Ingen Housz in relation to the early history o photosynthesis

Those, however, who were privileged to know th man, recall a serene and gentle personality and mind which ranged far beyond the confines of hi special field of work Always keenly interested in th classics, he had an avid interest also in ancient histor and ancient cultures, especially in the Aztec languag and culture On his extensive travels, Prof Ree was indefatigable in pursuing his interests in plan physiology, while also adding to his store of knowledge of both present and past customs and cultures These wide interests and experiences made him a delightful host and a welcome guest No accoun of Prof Reed should, however, omit referenc to his broad and deep interests in human affair and human welfare In individuals, whether students, colleagues or visiting men of science, he found a ready interest, his church claimed his loyalty and service, and to the American Association for the Advancement of Science he gave his counsel as one of its national officers for some years

Prof. Reed leaves his mark indelibly on the literature of botany and plant physiology he will long be remembered with affection by a wide circle of colleagues, students and friends in many lands

F C STEWARD
J DUFRENOY

## Prof W J Dilling

PROF WALTER JAMES DILLING, who had held the chair of pharmacology at the University of Liverpool since 1930, died at Coniston on August 18 at the age of sixty-four

Educated at Robert Gordon's College and the University of Aberdeen, he graduated M B, Ch B with honours in 1907 He became second assistant to Prof J A MacWilliam in the Department of Physiology and was afterwards appointed Carnegie research scholar in physiology In 1909, as Carnegie research fellow in pharmacology, he studied in Germany and was for a time first assistant to Rudolf Kobert, professor of pharmacology and physiological chemistry at the University of Rostock He returned to Aberdeen in 1910 to become lecturer in pharmacology, where he conducted a course in experimental pharmacology for medical students, which was the first of its kind in Great Britain In 1914 he was appointed to the new Robert Pollok lectureship in materia medica and pharmacology in the University of Glasgow His work there was interrupted by war service, and in 1915 he was commissioned in the R A M C, with which he served until 1919 After a further period in Glasgow he went as lecturer in pharmacology to Liverpool in 1920 His merits as teacher and administrator soon gained recognition, he received the title of associate professor in 1926 and in 1930 was appointed to the newly created chair of pharmacology

Prof Dilling was deservedly popular with his students His carefully prepared and constantly revised lectures were full of vitality and were embellished by humorous sallies which delighted his hearers He was dean of the Faculty of Medicine during 1924–35 and again during 1939–45 His wise tolerance and able administration earned him the gratitude of colleagues and students alike He was twice a member of the University Council He was at various times an examiner to the Universities of Oxford, Cambridge, London, St. Andrews, Bristol, Leeds, Sheffield, Birmingham and Wales

In 1938 he was nominated to the General Medical Council, and in 1948 became chairman of its Pharmacopœia Committee He was a Privy Council representative on the Council of the Pharmaceutical Society and served as a member of the Pharmacology Committee for the British Pharmacopœia, 1948

Prof Dilling was the author of many papers on physiological and pharmacological subjects Early researches led to the publication of an "Atlas of Crystals and Spectra of the Hæmochromogens" in 1910 Other studies included investigations into the pharmacological actions of certain unfamiliar plants, of quinine on the parturient uterus and of lead compounds He also wrote on medical historical subjects But it was as a writer of text-books that he excelled Very early in his career he edited Bruce's "Textbook of Materia Medica", which became widely known to generations of students as "Bruce and Dilling" Frequent revisions were undertaken with characteristic energy and thoroughness, and were remarkable not only for their clear presentation of the most recent developments in pharmacology, but also for their understanding of the clinical problems attending the application of drugs, new and old Under the revised title of "The Pharmacology and Therapeutics of the Materia Medica", the book had reached its eighteenth edition in 1944 and revision for the nineteenth edition was almost complete at the time of his death From 1940 onwards he contributed the important chapter on recent developments in drug therapy to the annual "Medical Progress" volume of the "British Encyclopædia of Medical Practice" He had a profound knowledge of his subject as applied to both veterinary and dental practice He was joint author, with S Hallam, of another widely used text-book, "Dental Materia Medica, Pharmacology and Therapeutics", now in its third edition

His interests were wide and embraced many subjects besides pharmacology He had a life-long love of music and was chairman of the Liverpool Philharmonic Society for several years At his home in Coniston he was a countryman, keenly interested in rural ways and Lakeland life, of which he acquired an extensive knowledge To a keen and critical intellect he joined the utmost friendliness, and those who approached him for advice or help found him ready to give freely of his time and energies to the solution of their problems During the Second World War he commanded the medical company of the University Senior Training Corps and spent long hours with his student stretcher bearers receiving casualties at the railway terminus, sometimes far into the night. These and other war-time activities took heavy toll of his energies and eventually of his health, and he never fully recovered from the prolonged strain which a high sense of duty imposed upon him His loss is mourned by a wide circle of friends He leaves a widow and two daughters R W. BROOKFIELD

## Mr C W. Parsons

CHARLES WYNFORD PARSONS was born in 1901 at Swansea, the son of Tom Posslethwaite Parsons He was educated at Bristol Grammar School, proceeded to St John's College, Cambridge, in 1920, and, after graduation in 1924, was appointed assistant in the Department of Zoology, University of Glasgow There he remained, attaining the position of senior lecturer, until his untimely death at Birmingham on August 26

Parsons's first published work was on the behaviour of *Amœba*; but his interests soon changed, as was but natural in a department then under the direction of Graham Kerr and noted for its contributions to vertebrate morphology and embryology After a valuable paper on the conus arteriosus in fishes, he received for examination the penguin embryos collected during the *Discovery* investigations, and his beautifully illustrated report on these, published in "Discovery Reports" in 1932, represents his major contribution to zoological knowledge It was followed two years later by an account of similar material collected during the course of the British Antarctic (*Terra Nova*) Expedition of 1910 This included embryos of the emperor penguin collected by Wilson, Bowers and Cherry-Garrard in the course of a terrible five-week journey in the antarctic winter of 1911 It was always a matter of pride to Charles Parsons that he was able, after a long series of misadventures at other hands, to publish the results of their labours

But his interests were far wider than research From the day of his arrival in Glasgow, Parsons threw himself wholeheartedly into the work of the Department and into the life of the University He was keenly interested in what was then the O T C and rose to the rank of major in command of the Artillery Unit He served on the Faculties of Science and Medicine, was for some time a member of Senate and sat on many University committees On three occasions he took charge for lengthy periods of the Department He took great pride in the Hunterian Museum of Zoology, which he represented on the Scottish branch of the Museums Association He was elected a fellow of the Royal Society of Edinburgh in 1933 and served on its Council He was a vice-president of the Royal Philosophical Society of Glasgow and was a member of the Executive Committee, later Council, of the Scottish Marine Biological Association, acting as chairman for several periods The marine laboratory at Millport owes much to him

By his colleagues in the Department of Zoology at Glasgow and in the University generally, as well as by innumerable students, he will long be remembered as a most lovable man He was an admirable teacher, always fresh and stimulating and keenly interested in his students He served under three professors of zoology, all of whom survive him—Sir John Graham Kerr, Dr Edward Hindle and the writer Each had the benefit of his completely unselfish devotion to the Department, and all unite in their appreciation of him as friend and colleague He was most happily married, and the profound sympathy of many friends goes out to Mrs Parsons and to their four children C M YONGE

# NEWS and VIEWS

## University of Birmingham

SIR RAYMOND PRIESTLEY, whose tenure of office of vice-chancellor of the University of Birmingham would normally end this year, has been asked to continue in office for a further period and has expressed his willingness to do so This decision will give much pleasure to students and staff, for they have a warm regard for Sir Raymond It will also give the vice-chancellor an opportunity of realizing at least part of the object for which he was appointed, namely, that of the bringing together of all the departments of the University on to the Edgbaston site and so ending the present fission.

A notable development in the coming session is the establishment of postgraduate courses in mechanical engineering, chemical engineering and metallurgy Arrangements are being made for thirty-six postgraduate students to be selected by the University from candidates who are graduates or have equivalent qualifications and who have spent some years in industry These will be assisted with grants of £220–£400 from the University Grants Committee For the accommodation of these postgraduate students a large house in Edgbaston has been acquired as a hostel which can hold up to forty men The success of the scheme requires the co-operation of industrialists who may have to make some sacrifice to enable some of their key men to avail themselves of this opportunity, but it is believed that the consequent benefits will well repay the sacrifice A considerable part of the new buildings of the Mechanical Engineering Department is already in use, and more will be available in the ensuing session Much of the equipment has been the gift of large firms who have shown sympathetic appreciation of the nature of closer contact between the University and industry

## Economy of Greenland

MUCH useful information about Greenland and valuable statistical tables relating to that country's demography, climatic conditions, trade, fishing industry and social life is contained in a work entitled "Economic Principles of the Greenland Administration before 1947" (pp 215, København C A Reitzels Forlag, 1949, 18 50 kr ) The author, Mr P P Sveistrup, is well qualified to write on the subject, as he has spent nineteen years in the administration of Greenland In recent years, Greenland's foreign trade has been largely concerned with the export of salted cod, the cod fisheries now having replaced sealing as the main economic activity The decline in sealing has been caused by hunting in the breeding grounds and possibly also by a change in climate, as there appears to be a close connexion between the quantities of pack-ice (which carries the seals with it) and the catch of seals This change has meant that Greenlanders have now to rely on imports from the outside world to a greater extent than formerly when the seals, through their various joint products—meat, blubber and skins—furnished most of the necessities for living The only mineral at present being worked is cryolite, which is of considerable economic importance The author devotes much of his space to the price policy that has been followed, and that which ought to be followed, by the administration He points out that Greenland's economic structure is such that export prices fluctuate far more violently than import prices, and he concludes that, since imports are necessary for existence, a trade monopoly which stabilizes prices and thus isolates the Greenlanders from the trade cycle is desirable To the economist, the sociologist and the geographer, Greenland is of especial interest in that, owing to its climate, it is very near the limit of minimal existence It is therefore to be regretted that the translation of this book from the Danish into English has not been well done and that much patience is required to unravel what is meant by many of the paragraphs

## The Census of England and Wales for 1931

THE Registrar-General for England and Wales has recently published the "General Report on the Census of England and Wales, 1931" (London H M Stationery Office, 10s net) This is the final publication of the Census of 1931 It was largely completed in 1936, but final completion was delayed by the necessity of concentrating on the supplementary county volumes, the last of which appeared in 1940 Shortage of staff and pressure of war-time work made publication during the War an impossibility As a result of the long delay, most of the material in the general report is now only of historical interest, as conditions have changed radically since 1931 The report contains an account of the machinery of the Census. together with a discussion of some of the more important general results and an account of some minor inquiries, such as the number of Welsh-speaking persons in Wales, and the distribution of the alien population Most of the figures in this volume have already appeared in previous Census publications, but the staff of the General Register Office have performed the task of summarizing and condensing the information with their usual lucidity

## Metabolism of Humming-birds

By measuring oxygen consumption, Oliver P Pearson has calculated the rate of metabolism of humming-birds at rest and in flight and their energy needs over a 24-hour period (*Condor*, 52, No 4, July–August 1950) Five anna (*Calypte anna*) and two allen (*Selasphorus sasin sasin*) humming-birds were studied and, resting in day-time, their rate of oxygen consumption was found to be higher than that of any other animal measured under comparable conditions This high rate is in part balanced in both species by a period of torpidity at night, during which body temperature falls and oxygen consumption decreases to a significantly low rate In captivity recovery from torpidity occurred spontaneously before daybreak, a peculiar feature was that torpidity did not occur in young anna humming-birds Pearson also investigated the non-stop flight range of humming birds and showed that the maximum flight-range of the ruby-throated humming-bird, a migratory species suspected of making long over-water flights, is 385 miles

## India Section of the Electrochemical Society

The Electrochemical Society, Inc (235 West 102nd Street, New York 25), is an organisation in the United States which was founded in 1902 to promote the advancement of electrochemistry, electrometallurgy, electrothermics, electronics and allied subjects A section for India of this Society has been recently organised with headquarters at Bangalore, this being the first Section to be formed outside the United States The officers of the Section are *Chairman*, Dr B K Ram Prasad, special officer, Electric Grid Offices, Government of Bombay, Bombay, *Vice-Chairman*, Dr K L Ramaswamy, deputy production superintendent, Government of India Fertiliser Factory, Sindhri, and Mr J Balachandra, lecturer in electrometallurgy, Indian Institute of Science, Bangalore, *Secretary-Treasurer*, Dr T L Rama Char, lecturer in electrochemistry, Indian Institute of Science, Bangalore The inaugural meeting of the Section was held during March 23–24 at the Indian Institute of Science, Bangalore, and was well attended by scientific workers, engineers, industrialists and others interested in the future of electrochemistry in India Dr B K Ram Prasad delivered the inaugural address and spoke on "Some Aspects of the Development of Electrochemical Industries in India" He indicated that there are great possibilities for the development of these industries, keeping in view the availability of raw materials, present output of electric power and future power development plans. Dr Prasad said that he felt glad that the Government of India had decided to establish an Electro-Chemical Research Institute at Karaikudi, and expressed the hope that the Planning Commission recently set up by the Government would consider in detail the development of electrochemical industries in India

## Electronics for Spectroscopists

The second annual summer school on electronics for spectroscopists, sponsored by the Photoelectric Spectrometry Group, which was held during July 8–15, was again organised at University College, Southampton Mr C G Cannon was organising secretary on behalf of the Group The syllabus of the course placed emphasis on electronic techniques used in all aspects of spectroscopy Lectures and demonstrations given by Prof. E E Zepler, S W. Punnett, T B Tomlinson and G H Johns (Department of Electronics), included amplifier theory, effects of feedback, design of selective amplifiers, D C amplifiers, sources of noise and the calculation of noise in circuits, stabilized power supplies, and general consideration of circuit design, testing and fault finding Prof A M Taylor gave a discourse on the "Optics of Spectrometers", which included illumination of entrance slit-collimator systems; errors to finite slit-widths, and the choice of slit-width, polarization by spectrographs, and problems of 'lining up' and focusing Two invited speakers contributed lectures on specialized subjects Dr A Elliott (Courtaulds, Ltd, Maidenhead) spoke on the theory, use and experimental techniques of polarized infra-red radiation, and Dr E F Daly (Unicam Instruments, Cambridge) lectured on the theory, mechanics and electronics of fast scanning of spectra, and on double-beam fast scanning with cathode ray tube presentation There were three visitors from overseas Dr E Kuyper (Royal Dutch Shell, Amsterdam); Mr F Woutman (C I M, Delft); and Dr M Sanz (Dr A Wander S A, Berne).

## Polish Academy of Science and Letters

The nineteenth annual publication of the Nature Protection Committee of the Polish Academy of Science and Letters contains English summaries of all articles Among these is one by Jan Zabiński describing the work done in Poland since 1945 to save the European bison from extinction The work has been initiated by the Bureau of Nature Protection, which, besides setting aside reserves in Poland, each year assigns a certain number of animals for exchange with other countries interested in the problem of bison protection Through Polish activity in the last four years two breeding centres have been established in the U S S R and one in Denmark, it is hoped that breeding centres will also be developed in Belgium, Switzerland and, perhaps, Czechoslovakia Other articles include one by Aleksander Kosiba on problems of Nature protection in the Arctic, Jan Walas on the edelweiss, Jan Boguslaw Szczepski on the biology of the mallard, and Roman J Wojtusiak on extinct and vanishing mammals

## International Collection of Cytological Preparations

An International Collection of Cytological Preparations, under the auspices of the International Union of Biological Sciences, is housed in the Carnoy Institute at Louvain, Belgium The Collection is in the charge of Prof P Martens, director of the Institute Cytologists of all countries are invited to deposit in the Collection some of the slides which have served as the basis of their published researches More than 8,000 preparations have already been assembled, Biologists are thus given the opportunity, by visiting the Collection, of comparing their own work with that of others The preparations deposited remain the property of the depositors, who may at any time reclaim them

### *Science Reports* of Tohoku University, Japan

Reports from the Research Institute for Iron, Steel and Other Metals of Tohoku University, Sendai, Japan, used to regularly appear in a Tohoku University publication called *Science Reports* Since 1944 and the issue of Vol 32, this publication has been suspended The Association of Research Institutes of Tohoku University has recently commenced the issue of a new set of *Science Reports*. This is divided into three sections, Series A, B and C, of which the first is devoted to physics, chemistry and metallurgy The scientific and technological reports of the Research Institute for Iron, Steel and Other Metals will be printed in Series A The first two numbers of Vol 1, Series A, were published in May and August 1949

### Earthquake Records at De Bilt, Netherlands

Dr F A Vening Meinesz, director-in-chief of the Royal Netherlands Meteorological Institute, states that, owing to war circumstances, the seismological station at De Bilt was not recording earthquakes during October 11, 1944–June 1, 1945 Fortunately, neither the instruments nor the building were damaged, and recording began again when electric power was available on June 1, 1945 The seismological bulletin issued for the period June 1–December 31, 1945 (Seismic Records at De Bilt, 33, 1945 Pp vii+16 ('s-Gravenhage Koninklijk Nederlands Meteorologisch Instituut, 1949 ) 1 f ), shows 189 recorded earthquakes which could be interpreted and timed The records have been reduced by Dr J Veldkamp, director of the Section for Terrestrial Magnetism and Seismology, and by Mr J Oldeman, scientific assistant The instruments in action during the period were three Galitzin seismographs, one astatic Wiechert horizontal seismograph and two Bosch horizontal pendulums The last three were, in general, interpreted only when necessary to supplement the Galitzin readings

### Colonial Service · Recent Appointments

The following appointments in the Colonial Service have recently been announced Dr E M Chenery (soil chemist, Agricultural Department, Trinidad), chemist, Agricultural Department, Uganda , C W L Fishlock (director of agriculture, British Honduras), senior agricultural officer, Tanganyika , G M Roddan (deputy director of agriculture, Kenya), director of agriculture, Nyasaland , R R Waterer (conservator of forests, Cyprus), conservator of forests, Kenya , G B Smart (medical officer, Hong Kong), pathologist, Hong Kong , V R S Beckley and W R Birch, agricultural officers, Kenya , A E Carlaw and M J W English, agricultural officers, Tanganyika , J M B Harley, research officer (entomologist), East Africa High Commission , E W King, agricultural officer, Uganda , H H Roberts, agricultural officer, Northern Rhodesia , E T Wilnot, agricultural officer, Nyasaland , D N Holt, geologist, Nyasaland , L D Sanders, geologist, Kenya , Dr S G Cowper, pathologist, Mauritius , J H Caley, staff surveyor, Forest Department, Kenya , R S Pinniget, veterinary officer, Tanganyika , D P Franklin, agricultural superintendent, Nigeria , D V Mackenzie, assistant meteorologist, Nigeria

### Announcements

The new building of the Imperial Forestry Institute, Oxford, will be opened by H R H Princess Margaret on October 19

The Council of the British Welding Research Association has awarded the Welding Research Prize for 1949 to Dr K Winterton, Mr J G Ball and Mr C L M Cottrell for their joint paper entitled "A New Weldability Test for Magnesium Alloy Sheet" This Prize (£100) has been given by the British Oxygen Co , Ltd , which has offered to provide a prize fund for three years for a competition relating to welding The closing date for entries for the 1950 competition has been extended to December 31, 1950 Further information can be obtained from the Secretary, British Welding Research Association, 29 Park Crescent, London, W 1

Mr Paul Adorian, assistant managing director of Broadcast Relay Services, Ltd , has been elected president of the British Institution of Radio Engineers Mr Adorian, who was a student at the City and Guilds Engineering College, joined the Rediffusion group of companies in 1932 as a development engineer and was appointed chief engineer in 1936 His main technical work has been on the development of relay systems and industrial electronics, and he has been directly associated with work on synthetic training methods for airmen

Appointments to the [Australian] National Standards Commission have been announced as follows *Chairman*, Prof L G H Huxley (professor of physics, University of Adelaide) , *Members*, Dr G H Briggs (chief, Division of Physics, Commonwealth Scientific and Industrial Research Organisation) Mr N A Esserman (chief, Division of Metrology, C S I R O ), Mr W M Holmes (formerly superintendent of weights and measures, Victoria) and Mr F J Lehany (chief, Division of Electrotechnology, C S I R O ) The Commission advises on the Commonwealth standards of measurement held at the National Standards Laboratory, Sydney, of the Commonwealth Scientific and Industrial Research Organization

Sir George Beilby Memorial Fund awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made at intervals to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy In general, the awards are granted to younger men and women for original work done over a period of years In 1949 three such awards were made, each of 100 guineas Awards may be made early next year, and the administrators request that their attention be directed to outstanding work of the nature indicated not later than December 31 Communications should be addressed to the Convener of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W C 1

Erratum In the communication "Monoclinic Thorium Silicate" by Prof A Pabst in *Nature* of July 22, p 157, for the unit-cell dimension $c_0$ = 5 54 A , read $c_0$ = 6 54 A.

# CHEMISTRY OF MUSCULAR CONTRACTION

THE "Chemistry of Muscular Contraction" was discussed jointly by Sections B (Chemistry) and I (Physiology) of the British Association on September 6, during the recent meeting at Birmingham

Prof Ernest Baldwin (University College, London) gave an introductory address, stressing the uncertainty of present views on muscle chemistry He began with a brief historical review from the period beginning with Fletcher and Hopkins's classical experiments to the present day The work of Fletcher and Hopkins provided the first unequivocal evidence that muscular activity is associated with the degradation of glycogen and the formation from it, under anaerobic conditions, of lactic acid That glycolysis is not, however, the immediate energy source was discovered by Lundsgaard's demonstration of 'alactic acid' contraction in muscles poisoned with iodoacetate The activity of iodoacetate-poisoned muscle is attended by the decomposition of phosphagen, glycolysis being totally abolished Exhaustion of the supplies of phosphagen is promptly followed by rigor, and hence it follows that phosphagen breakdown is a more immediate source of energy than glycolysis

Phosphagen breaks down rapidly if added to fresh muscle extracts prepared after the method of Meyerhof, but fails to decompose if added to exhaustively dialysed extracts This, as Lohmann was able to show, was due to the absence from dialysed extracts of adenosine monophosphate Subsequent work showed that, in fact, phosphagen (creatine phosphate) reacts with adenosine*di*phosphate to yield adenosinetriphosphate and free creatine through the Lohmann reaction, a "phosphate-plus-energy transfer"

Creatine phosphate + adenosinediphosphate $\rightleftharpoons$ creatine + adenosinetriphosphate

The involvement of adenosine*mono*phosphate in Lohmann's original experiments was due to the intervention of another enzyme, myokinase

Since resting muscle contains both adenosinetriphosphate and a powerful adenosinetriphosphatase, but does not contain the di- or mono- phosphate, it seems certain that, in alactic acid contraction as well as in unpoisoned muscle, the breakdown of phosphagen must necessarily be preceded by some breakdown of adenosinetriphosphate to yield the diphosphate Phosphagen is not known to be broken down in any other way in muscle or in muscle extract, but only by interaction with adenosinediphosphate Thus the decomposition of adenosinetriphosphate into the diphosphate, inorganic phosphate and energy assumed the position of the earliest known energy-yielding reaction in extracts and probably, therefore, in muscle also

For this there is at present no direct evidence, and it has not yet been possible to meet A V Hill's challenge to biochemists to produce such evidence, mainly because sufficiently refined methods of chemical analysis are not at present available

The present phase of muscle chemistry began with Engelhart and Lubimova's demonstration, now amply confirmed, of the adenosinetriphosphatase nature of myosin, the predominant protein of muscle, and a protein, moreover, which is known to have contractile properties Most early preparations of myosin were, however, more or less grossly contaminated with actomyosin, the product of interaction of myosin with a second muscle protein, actin Actomyosin consists of long, fibrous particles, and much recent research has amply demonstrated the fact that these particles undergo more or less extensive shortening if treated with adenosinetriphosphate, an effect which is exceedingly specific

Such at present seems to be the physicochemical basis of muscular contraction In relaxed muscle, both adenosinetriphosphate and actomyosin are present, but are apparently separated in some way until the arrival of a stimulus to contraction When the two come together the fibres shorten, apparently undergoing dissociation to yield free actin and a myosin–adenosinetriphosphate complex This latter is, in effect, an enzyme-substrate complex Only now does adenosinetriphosphate undergo decomposition, yielding, so far as we know, adenosinediphosphate, inorganic phosphate and energy, myosin is regenerated and reacts again with the actin to re-form the longer threads of actomyosin If this picture is correct, relaxation rather than contraction would have to be considered as the process in which adenosinetriphosphate is broken down, the energy arising from this breakdown being utilized to restore the contracted muscle to its relaxed configuration. The contracted condition, in fact, would seem to be the truly resting state of muscle, a state in which adenosinetriphosphate and actomyosin can perhaps exist as a temporarily stable intermediate reaction complex

Prof Baldwin sees in such a theory as this the beginnings of an understanding of the behaviour of the adductor muscles of lamellibranch molluscs, many of which can keep the shells of the animal closed for long periods of time and against relatively enormous loads, yet without any very appreciable consumption of energy He suggested that more attention might now be profitably paid to these and similar unstriated muscles

In conclusion, Prof Baldwin remarked on the frequent revolutions that have already taken place in the field of muscle chemistry, and commented that yet another may be imminent The picture he had given of the present position was, he pointed out, only one possible interpretation of the experimental facts—something in the nature of an "Aunt Sally", put up in the confident expectation that it would shortly be knocked down

Dr S V Perry (School of Biochemistry, Cambridge) presented a paper entitled "Adenosinetriphosphate and the Isolated Myofibril" He reminded the audience of the principal structural features of a typical, intact striated muscle Normal methods of extraction with saline media of low and high ionic strengths extract the sarcoplasmic and myofibrillar constituents respectively, but entail complete structural disorganisation of the tissue By the use of a collagenase obtained from *Clostridium welchii*, it has been possible, however, to disintegrate only the connective tissues of the muscle and obtain in this way a fine dispersion of intact myofibrils Their detailed structure was illustrated by a beautiful electron micrograph which showed cross-striations corresponding closely to those of the whole muscle The micrograph revealed the existence of protein threads, presumably of actomyosin, running throughout the length of the myofibril and apparently anchored at the $Z$ bands These isolated myofibrils shorten to about 25 per cent of their initial length in the presence of 0 001 $M$ magnesium ion and 0 0004 $M$ adenosinetriphosphate A further electron micrograph showed the concertina-like appearance of the shortened myofibril and the disappearance of most of the finer structures originally visible

The myofibrils decompose adenosinetriphosphate, if they are not carefully prepared, the triphosphate breaks down as far as the monophosphate Apparently this is due to the presence of myokinase, since repeatedly washed preparations carry the breakdown only as far as the diphosphate If the muscle is put into rigor by freezing and thawing, there is gross disruption of the structure and normal myofibrils cannot be obtained Muscles in rigor mortis do not undergo this disruption, and they yield good myofibril preparations As Dr Perry pointed out later, the decomposition of adenosinetriphosphate which occurs in rigor mortis, as opposed to that in freeze-thaw rigor, does not appear to be accompanied by the shortening of actomyosin, but may be due to the newly discovered adenosinetriphosphatase of Meyerhof, which appears to be localized in the sarcoplasm and of which the function is still obscure

Dr Perry went on to describe experiments which showed that the effects of magnesium and calcium ions on the adenosinetriphosphatase activity of isolated myofibrils differ in some respects from the effects obtained with extracted actomyosin Isolated myofibrils also show differences from artificial threads made from actomyosin in their physical behaviour with adenosinetriphosphate, in particular, the shortening of actomyosin threads is essentially dehydrative and is isodimensional That of the myofibrils, however, is longitudinal, with little or no lateral change, and thus more closely resembles normal muscle contraction These differences, Dr Perry believes, are due to differences in the structural organisation of the two kinds of preparations He then passed on to discuss possible relationships between the enzymic and structural organisation of the muscle cell on one hand and the phenomenon of cellular contractility on the other In the main, these appear to be in agreement with the general picture previously given by Prof Baldwin

Dr J R Bendall (Low Temperature Research Station, Cambridge), in a paper entitled "Shortening of Muscle in rigor mortis", chose to assume that the contraction of a muscle passing into rigor mortis can be considered as a very protracted and irreversible form of muscular contraction, though he was well aware of the dangers which this assumption implies Mammalian (rabbit psoas) muscle going into rigor does not shorten much at room temperature, but is capable of doing a good deal of mechanical work at higher temperatures (37°) and especially at high $p$H (7 25) This shortening and work-performance are associated with three chemical phenomena known to occur in normal muscle, namely (*a*) fall of $p$H due to lactic acid formation, which can be minimized by using starved or paralysed animals, (*b*) breakdown of phosphagen, and (*c*) breakdown of adenosinetriphosphate

A number of slides in which the magnitudes of these three phenomena were plotted against time, together with plots of the degree of shortening, all on a percentage basis of the initial values, were shown by Dr Bendall The rate of shortening and the amount of work done is higher at higher $p$H, but neither the rate of $p$H change nor that of phosphagen breakdown parallels the rate of shortening On the other hand, the breakdown of adenosinetriphosphate begins at about the same time as the onset of shortening, and the two processes are well correlated The disappearance of phosphagen in spite of vigorous glycolysis is almost complete before adenosinetriphosphate breakdown assumes major proportions Shortening is never found to begin before adenosinetriphosphate breakdown

If Dr Bendall's assumption be correct, his results would indicate that the breakdown of adenosinetriphosphate is associated with the phase of shortening rather than with that of elongation in normal muscle, a conclusion diametrically opposed to the scheme proposed by Prof Baldwin Dr Bendall pointed out that his observations would account for the thermal data obtained by Prof A V Hill if his initial assumption were true

There were few comments, and little discussion, apart from some observations on the properties and behaviour of artificial threads of actomyosin and myosin, which took place mainly between the speakers themselves It appeared that the behaviour of actomyosin threads, free to shorten or placed under load, can be accounted for by the known properties of actomyosin, and that some important differences between these threads and isolated myofibrils can be attributed to differences in the orientation of the actomyosin fibres in the two cases Prof Baldwin, in concluding the discussion, said there had been much more agreement between himself and his fellow contributors than he had expected, and he was particularly interested in the contrasts between Dr Perry's myofibrils and artificial actomyosin fibres of varying degrees of orientation

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# SCIENTIFIC INTERESTS OF ADULTS*

By W E FLOOD

Education Department, University of Birmingham

THE investigations described here form part of a wider study of the techniques of presenting science, by book or lecture, to the ordinary, non-academic adult Exploratory examinations were made of the relative interest in the various branches of science and of the relative appeal of different lines of approach to scientific topics

A new classification of twenty-three science 'subjects' was devised for the investigation of interests This included the recognized branches of science (for example, astronomy, geology) and also certain aspects of science such as industrial applications, new discoveries, scientific biography, and public direction and use of science The interpretations to be placed on the twenty-three subject headings were briefly explained on the test-sheets used in the inquiries

At this early stage of the study it seemed desirable to examine the preferences of adults who have revealed some definite interest in science A test-group of about four hundred adults (called Group I) was constructed from people voluntarily attending science lectures provided by the Workers' Educational Association (and a few by university extra-mural departments) in various parts of the country. They were asked to indicate their degree of interest in each of the twenty-three subjects on a five-point scale ranging from *A* (this interests me very much) to *E* (this does not interest me at all)

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* Substance of a paper read on September 1 before Section J (Psychology) of the British Association meeting at Birmingham

The distribution of the *A*, *B*, *C*, *D*, *E* markings in any one subject usually indicated a definite central tendency, though in a few subjects the weight was largely concentrated at one end or other of the scale In no case was there weight at both ends of the scale with a minimum between

Differences between the markings in the twenty-three subjects, and between the markings by each sex, were analysed by chi-square methods For the purpose of simple presentation of the results, a numerical interest-rating was evaluated by assigning 100, 75, 50, 25, 0 to the markings *A*, *B*, *C*, *D*, *E* respectively and taking the average The results so obtained, when compared with those obtained by more rigorous methods, were found not to be misleading

The average interest-rating for the twenty-three subjects was 58 for both sexes, that is, rather above *C* (moderate interest) The male interest was greatest in future trends and possibilities (77) and new discoveries (74) Industrial applications and medicine, disease and health were also popular There was little interest in aeronautics (35), in public use of science, and in text-book fundamentals Females indicated greatest interest in medicine, disease and health (85) and pure biology (83) Psychology and applied biology occupied the next places They, too, ranked aeronautics of least interest (24), and expressed little interest in the several branches of engineering and in radio

The most striking sex-difference was the wider range of interest-ratings shown by females (males 77–35, females 85–24) The range was most marked in the 20–40 age-group (psychology 92, aeronautics 22) Females appear to be more extreme in their preferences The male interest was significantly higher in text-book fundamentals, branches of engineering, aeronautics, and future trends—subjects mainly associated with general usefulness and vocation Female interest was significantly higher in medicine and health, pure and applied biology, psychology, biography, and anthropology—all subjects associated with 'life' A curious result was a higher female interest over Group I in meteorology

A similar investigation was carried out with the better classes of men in an Army education unit. These men were not necessarily interested in science at all The average for all subjects was 55, but possibly this arose from a desire to please In more than half the subjects the interest-ratings were very similar to those of the men in Group I This suggests that the results for Group I may be representative of a wider range of the public The Army men, as might be expected, were more interested than men of Group I in mechanical engineering, aeronautics, and radio, but were much less interested in biology, astronomy, and geology

A scientific topic, presented in a book or lecture, can often be approached from a number of angles Six possible approaches (or points of view) were identified for study An examination was made of the preferences of the adults in Group I It was found that both males and females prefer a presentation built around the direct effects of the topic on the individual They also liked approaches through the pure science of the topic and through future hopes and possibilities. They expressed very little interest in historical, biographical, and dramatized approaches and in presentations based upon the interplay of science and social life

The test was repeated with about four hundred students (both sexes) in emergency training colleges About fifty of these were taking science in their course (but not to an advanced standard) This sub-group showed a very strong preference for approaches through practical applications and expressed some interest in the pure science of a topic. They were not so interested in future trends, but more interested than Group I in social interactions There was practically no support for a purely historical approach The remaining 350 students were not studying science, and possibly were not interested in it They felt that they would be most interested by approaches through direct applications (but less strongly than previous groups) and, of special importance, welcomed approaches through history, biography, and social interactions Approaches through pure science and future trends would meet with little success.

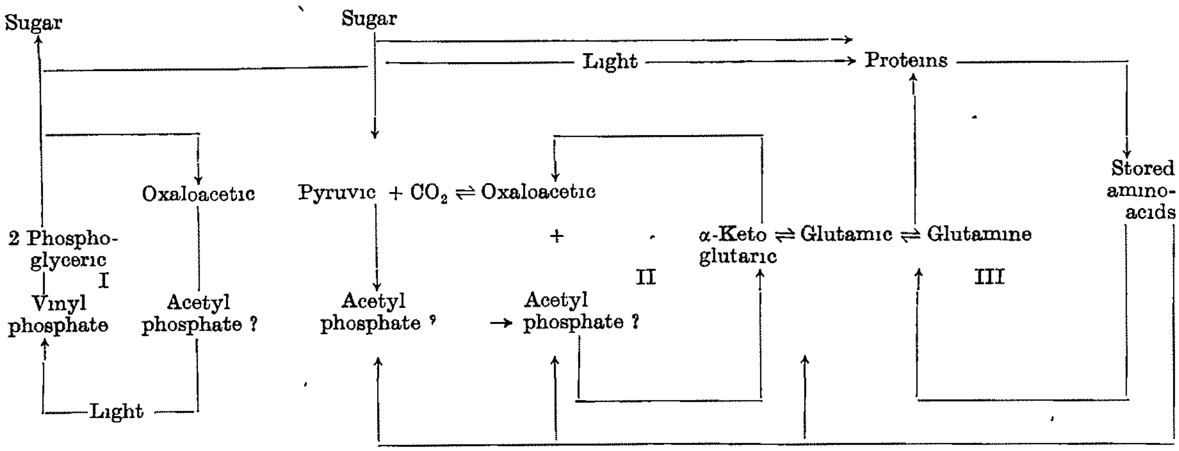
It seems that adults who know some science (as probably did those in Group I) prefer a presentation 'undiluted' by history and social effects , but those who know little science are more likely to be interested in a presentation based upon history and upon the effects of science on the individual and society

# PHOTOSYNTHESIS AND RESPIRATION: A REINTERPRETATION OF RECENT WORK WITH RADIOACTIVE CARBON

By Prof F C STEWARD and Dr. J. F. THOMPSON
Cornell University, Ithaca, New York

CONCERNING the old, but still challenging, problem of the first product of photosynthesis and the subsequent path toward sugar, two different groups of workers have recently reached different conclusions

The active California group, led by Calvin and Benson[1,2,3], conclude that the immediate receptor of carbon dioxide is a two-carbon compound (vinyl phosphate), the formation of which is stimulated by light, and the first fixation product to be identified is a relatively simple substance (2-phosphoglyceric acid) According to Calvin and Benson, the course of metabolism of green cells in the light is quite different from that which obtains in the dark Calvin discredits the old view that respiration in green cells in the light proceeds relatively unaffected by their concomitant photosynthesis and, from the experimental data, now concludes that respiration in the light is arrested Metabolism, which in the dark proceeds through a Krebs-type carboxylic acid cycle culminating in the production of carbon dioxide, is regarded as diverted in the light to proceed through another cyclical process leading to the fixation of carbon dioxide and the synthesis of carbohydrates by the reversal of glycolysis This novel scheme embodies several salient features



Cycle I Simplified from Calvin[1]
Cycle II Simplified Krebs cycle
Cycle III See ref 9 and references there cited

(1) The receptor of carbon dioxide is formed in the light and is a simple two-carbon compound

(2) The subsequent fixation of carbon dioxide is not specifically light-activated, in fact, all the reactions of carbon may occur in the dark if the cells are first stimulated by light

(3) There is a contrasting relationship between respiration (occurring only in the dark and visualized as though it proceeds only through a carboxylic acid cycle) and photosynthesis (which stems from the light-activated 2-carbon intermediate) Respiration and photosynthesis are regarded as mutually exclusive This is shown by the accompanying figure, in which the cyclical processes I and II are simplified and adapted from Calvin[1] The cyclical process I occurs only in the light, and the familiar cyclical process II occurs only in the dark, according to Calvin

In sharp contrast stand the results of the Chicago school[4,5] Their findings are interpreted to mean that the first product of photosynthesis is a relatively stable substance—not a simple one—but one which, though it remains unidentified, can be isolated and examined by extraction procedures which are described According to the Chicago school, the essential intermediates of photosynthesis are unique, and the essential steps of the light process cannot be interpreted by reference to dark fixation, which is regarded as a completely separate process unrelated to the essential step of photosynthesis

In each case, the laboratories in question have utilized radioactive carbon dioxide, and each case is supported by impressive evidence The problem now becomes one of interpretation The following analysis attempts to place some of this work in a different perspective, and this may afford some aid toward resolving the discrepancy between the two schools The lesson to be learnt is, however, that photosynthesis is not merely an isolated chemical problem As it proceeds *in vivo* it occurs in a milieu capable of, in fact obliged to, carry out numerous other metabolic processes which are consistent with the maintenance and the growth of cells Our thesis is that the interpretations obtained by the Calvin school have ignored the concomitant processes of protein synthesis and breakdown, and in so doing have drawn conclusions which are physiologically improbable

One must first emphasize some features of nitrogen metabolism in plants which are familiar to plant physiologists and easily verifiable from the literature, These are as follows

(1) The green leaf—or the green cell—in the light is a prominent region of protein synthesis not because light enters into the reactions of protein synthesis *per se*, but rather because the green cell in the light is well supplied with the substances necessary for protein synthesis These may be either sugars or the intermediaries of sugar synthesis by photosynthesis In fact, it has been suggested that protein synthesis in the green leaf may proceed by a different mechanism than in the case of cells which are not green[6,7]

(2) Rapid synthesis and breakdown of protein is to be regarded as a constant feature of plant, as well as of animal, cells even where the actual content of protein remains steady by balancing the rates of breakdown and of synthesis[8]

(3) Glutamic acid is believed to hold a very special position in nitrogen metabolism—so much so that it has been suggested that the free amino-acids are not merely linked up to form protein, but that they constitute a ready reserve of organic nitrogen which becomes available for synthesis inasmuch as it is released by oxidative deaminations or is transferred by transaminations and the nitrogen is canalized through glutamic acid or glutamine en route to protein—glutamic acid being regarded as the ultimate donor of the nitrogen actually incorporated into protein[9]

(4) The association of a carboxylic acid respiratory cycle with a nitrogen cycle of synthesis and breakdown is a necessary and now familiar way of emphasizing the role of amino-acids in furnishing substrates for respiration, and of respiration and sugar metabolism in furnishing the energy, the carbon skeletons and the impetus for protein synthesis Such schemes utilize the fact that α-keto-glutaric acid and glutamic acid constitute the major link between carbon compounds involved in respiration and nitrogen compounds involved in nitrogen metabolism[9,10,11,12]

(5) Carboxylation (at the level of pyruvic acid–oxaloacetic acid) plays a key part in maintaining the Krebs carboxylic acid cycle Some circumstances tend to maintain a very low level of carbon dioxide and to foster decarboxylations, for example, especially efficient aeration with carbon dioxide - free air of submerged cells and tissues have been shown to

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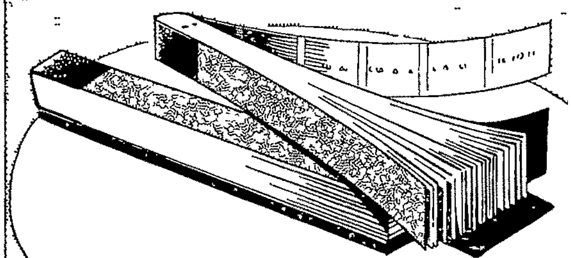

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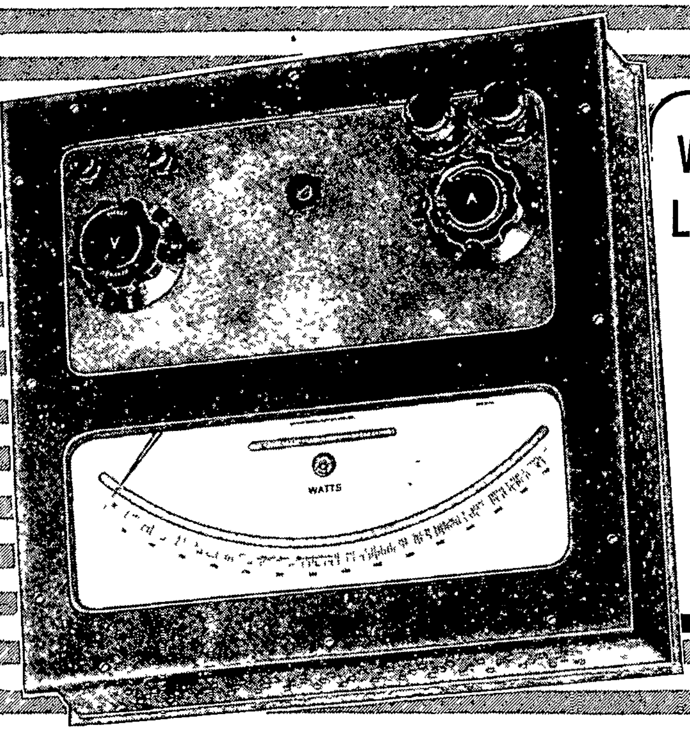

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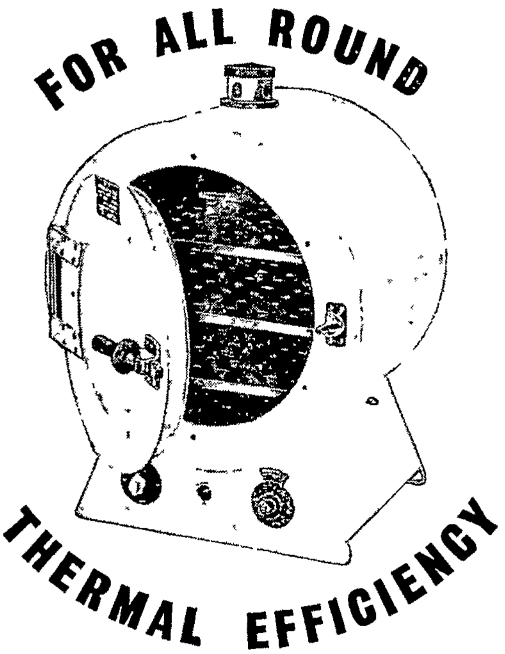

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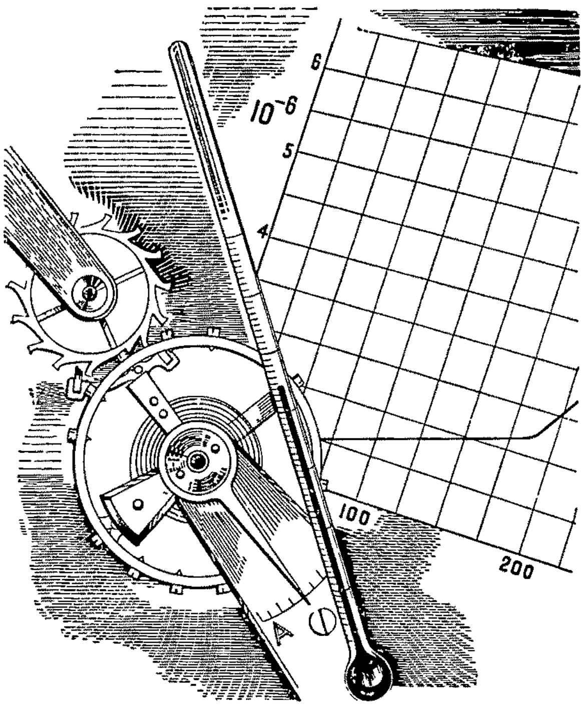

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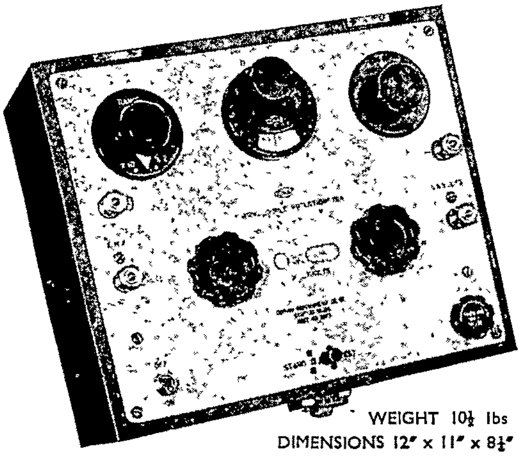

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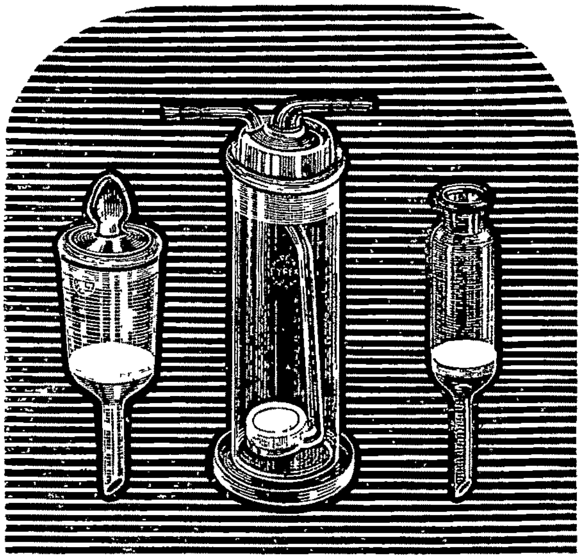

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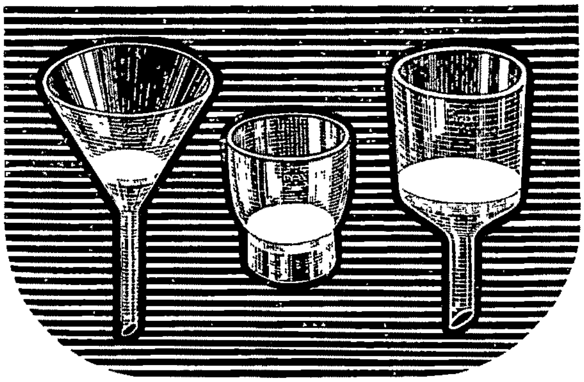

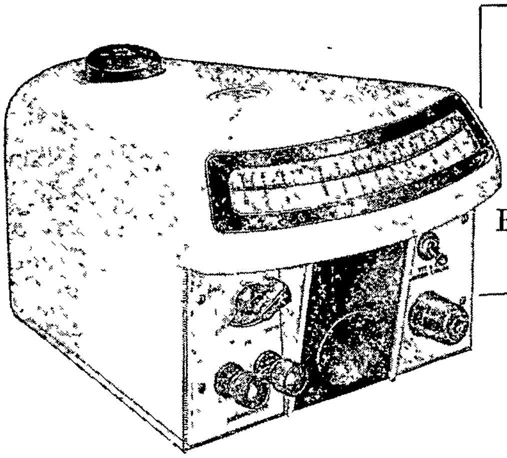

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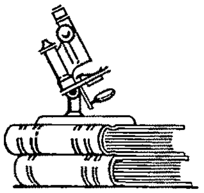

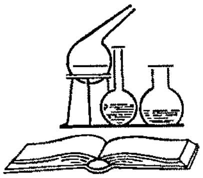

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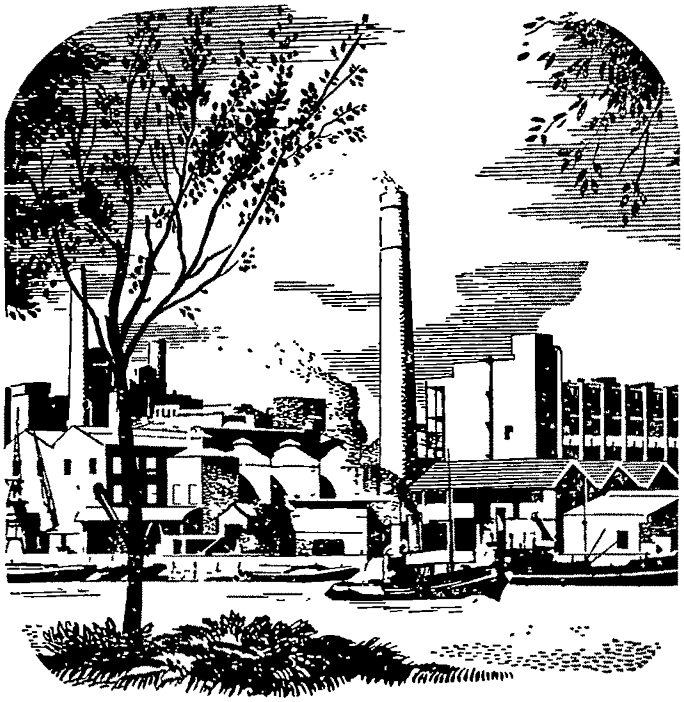

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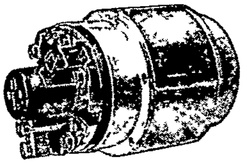

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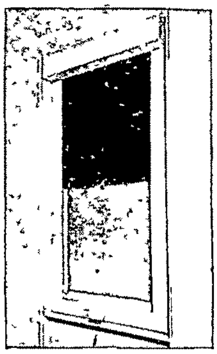

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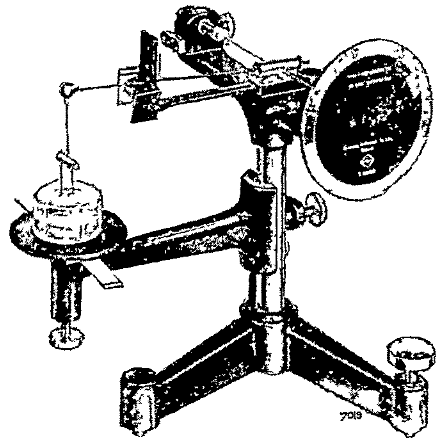

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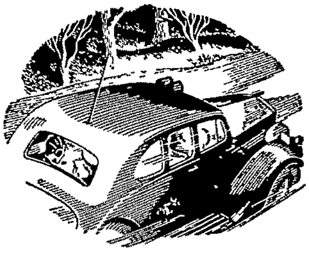

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stimulate protein synthesis in cells which are not green (cells of storage organs) Conversely, aeration, coupled with an external supply of carbon dioxide, can completely suppress protein synthesis[13]. These facts were later construed to mean that $p\mathrm{CO}_2$ played a regulatory part in respiration and protein synthesis[9] When the reactions of carboxylation were blocked by lack of free carbon dioxide, and decarboxylations fostered, the carboxylic acid cycle could only be maintained by supplying α-keto-glutaric acid from glutamic acid in lieu of pyruvic acid This, in effect, diverted sugar metabolism from pyruvic acid and respiration via the carboxyl acid cycle to protein synthesis, utilizing the nitrogen donated by amino-acids, particularly glutamic acid and glutamine Thus, the conditions for synthesis of protein coincided with low internal concentrations of carbon dioxide These conditions have been achieved by rapid aeration with carbon dioxide - free air in non-green cells, though the interesting possibility was raised that the same mechanism might operate to foster protein synthesis in the light in green cells[9]

These relationships, visualized in terms of an interlocking carboxylic acid cycle and a nitrogen cycle, are shown in the form of Cycles II and III of the accompanying simplified scheme The purpose of this scheme is to stress that deaminated residues of amino-acids may enter the carboxylic acid cycle and contribute to respiration, while the nitrogen groups may be recondensed to protein, utilizing a carbon framework derived ultimately from sugar or its precursors Furthermore, the conditions of low carbon dioxide tension, such as prevail in green cells in the light, divert the metabolism from the use of sugar, via pyruvate, in the carboxylic acid cycle to the use of α-keto-glutarate from glutamic acid

The unconventional views of Calvin and his co-workers on the balance of respiration and photosynthesis rest briefly upon the following observations

(1) $\mathrm{C^{14}O_2}$ applied to *Chlorella* and other green cells only enters glutamic acid and the intermediates of the Krebs cycle (succinic, fumaric, isocitric) in the dark, and moreover when the dark fixation occurs in cells not previously stimulated by exposure to light

(2) The dark fixation which occurs after previous light stimulation is in all essential respects identical with ordinary photosynthesis

(3) In the light $\mathrm{C^{14}O_2}$ enters into combination with a light-stimulated intermediate (vinyl phosphate) and passes through 2-phosphoglyceric acid en route to sugar—all these reactions being possible in the dark granted the supply, by previous light stimulation, of the two carbon receptors

(4) There is a number of substances, aspartic acid, serine, alanine, malic acid, the general occurrence and content of carbon-14 of which, both in the light and the dark, are attributable to their ready derivation from pyruvic or oxaloacetic acids

(5) The two-carbon light-stimulated intermediate (vinyl phosphate) is hypothetical, but a compound which releases radioactive acetaldehyde on heating for 10 min with dilute acid occurs

The Calvin group postulates that the carboxylic acid cycle is suppressed in the light because acetate or acetyl phosphate, a necessary reactant with oxaloacetic, is kept by light in the form of vinyl phosphate which cannot enter the Krebs cycle

There is no proof that respiration proceeds *only* through a Krebs cycle, as Calvin *et al* seem to suggest Even so, however, there is an alternative interpretation of the experimental facts brought forward by the Calvin school, this follows by combining the ideas embodied in Cycles I and II with those of Cycles II and III, as shown in the figure These ideas are as follows

(1) Of necessity, the carboxylic acid cycle of respiration proceeds in green cells *both* in the light and in the dark, but with different substrates furnishing the carbon source It is inconceivable that green cells in the light do not respire

(2) In the light, growth and synthesis of protein predominate over its breakdown, the carboxylation reactions of the carboxylic acid cycle are eliminated by the low internal $p\mathrm{CO}_2$[*], and this cyclic process is now maintained by the carbon residues fed into it from amino-acids Meanwhile, the nitrogen groups pass to protein utilizing carbon compounds which are either en route to, or from, sugar (that is, compounds which, under these conditions, are diverted from respiration to protein synthesis) Therefore, carbon-14 supplied as $\mathrm{C^{14}O_2}$ to green cells in the light would not be expected to enter into the composition of glutamic acid and the intermediates of the carboxylic acid cycle *until after it had been incorporated into protein* and until appreciable protein breakdown had occurred.

(3) In the dark the carboxylic acid cycle is maintained in the usual way from the products of glycolysis (Cycle II of the figure), and on the addition of $\mathrm{C^{14}O_2}$ the intermediate compounds of this cycle (and the amino-acids derivable from them, especially glutamic acid) readily become radioactive by dark fixation

(4) The ready occurrence of carbon-14 in glutamic acid when the $\mathrm{C^{14}O_2}$-treated *Chlorella* cells are in the dark and its comparative absence when the cells are in the light have, therefore, more direct significance for the problem of nitrogen metabolism than for the problems of respiration and photosynthesis *per se* These observations are compatible with the generally accepted view that the green cell in the light is a potent centre of protein synthesis (because the green cell in the light has access to photosynthetic intermediates as well as to products of nitrate reduction and now because the low $p\mathrm{CO}_2$, caused by the photosynthesis itself, will draw the carbon skeletons of amino-acids, via glutamic acid, into the respiratory cycle and divert their nitrogen groups into protein)

Therefore, the interpretation of what the Calvin school has shown may *not* be that the Krebs cycle and respiration are suppressed by light, but rather that, under these conditions of reduced carbon dioxide tension in the cells, these processes utilize carbon sources drawn from amino-acids rather than sugar

These relationships may be visualized in the combined scheme of the figure The argument of Calvin *et al* is that Cycle II ceases in the light Our view is that, in the light, Cycle II is maintained from glutamic acid and the deaminated residues of amino-acids, and that the light-stimulated protein synthesis uses carbon from photosynthetic intermediates and nitrogen groups donated by glutamic acid A still more recent summary by Benson and Calvin[14] makes this point of view reasonable, for these authors write (l c , p 30) "The major portion of the insoluble products formed in the first few minutes by algæ was protein Acid hydrolysis produced radioactive amino-acids in approximately the same relative amounts as those in the cell extract Protein obtained from longer experiments (5 to 10 min ) contained more activity than that found in several amino-acids present in the cell extracts Glutamic acid, by far the largest free amino-acid reservoir, was not converted into protein in amounts commensurate with its concentration " This seems to be consistent with the fundamentals of our interpretation, namely (1) protein is formed rapidly in the light and contains carbon-14 furnished as $C^{14}O_2$, (2) glutamic acid is present in large amounts, (3) all the *carbon* of the glutamic acid does not go into the protein, though the nitrogen, which was not labelled, may

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[*] The only treatments of Calvin *et al* which could have produced a low carbon dioxide tension in the cells by means other than photosynthesis were those where they used a 'helium sweep' which would also produce, especially in the dark, anaerobiosis this would also tend to limit protein synthesis

The outstanding contribution of the Calvin school to our knowledge of photosynthesis is the recognition that 2-phosphoglyceric acid is a product of $C^{14}O_2$ fixation in the light or, after light stimulation, in the dark This result will have far-reaching consequences However, the Calvin school has interpreted its other results in ways which are physiologically improbable, and in so doing seems to have overlooked possibilities based on other concomitant physiological processes, which enable its data to be interpreted in other ways In this brief analysis we have tried to show certain of these possibilities.

Finally, photosynthesis as it proceeds *in vivo* occurs in a system capable of protein synthesis to understand one process we may need to comprehend more of its relations to the other There may be a clue here also to the behaviour of isolated chloroplasts for, so far as is known at the present time, they are incapable of growth and division and they are also incapable of reducing carbon dioxide

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# CINEMATOGRAPHIC RECORDING OF THE VELOCITY OF ARTERIAL BLOOD-FLOW[1]

By J M POTTER and D. A. McDONALD

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THE direct study of blood-flow in intact arteries is difficult for two main reasons the thickness and opacity of the vessel walls, and the relatively high velocity of flow within them

We have developed a technique in which these difficulties are reduced The arteries within the cranium and vertebral canal have thin walls in proportion to their diameters Among these arteries is the basilar, which in the rabbit is some 1 5 cm in length with an external diameter of approximately 1 mm It has been exposed in its proximal half and its contents examined through its translucent wall with a dissecting microscope

The basilar artery is formed by the fusion of the two vertebral arteries, each of which is rather more than half the calibre of the basilar We have shown[2] the flow in it to be streamlined (laminar), because dye introduced into one vertebral artery remains in a distinct stream on its own side in the basilar

In order to measure the velocity of flow in the artery, we have recorded cinematographically the passage of injected substances along it This has been done with the 'Kodak' high-speed camera which works at speeds up to 3,000 frames per sec Extension tubes were used so that the object image ratio was 3 4 The light source was a 500-watt 'Osira' high-pressure mercury arc-lamp, focused by a condenser and projected into the field by a mirror from a Watson's microscope strapped to the lens-extension tube system To avoid overheating the preparation, 'Calorex' glass was interposed, although this entailed a loss of light of some 15 per cent The effective efficiency of the 'shutter' system of the camera was about 20 per cent, so that at 3,000 frames per sec the effective exposure was 1/15,000 sec (The camera actually has no shutter, the film is traversed continuously behind a revolving block of glass ) The provision of sufficient light was therefore the outstanding technical difficulty in photographing blood Originally a cadmium mercury lamp was used, but the red in it was not effective enough to contrast dark dyes with blood under the experimental conditions, that is, relative under-exposure, and using a heat filter which was slightly green Therefore, it was necessary to photograph the blood as black, and introduce contrasting substances that photographed white

Successful results were obtained using 0 05 per cent fluorescein solution, and globules of olive oil (stabilized with 'Teepol') Injections were made into the axillary artery some 6 cm nearer the heart The smallest globules seen were estimated at 0 07–0 08 mm and the largest about 0 2 mm As they had to pass up the vertebral artery, which has an internal diameter of about 0 5 mm, this was considered to be satisfactory

The film is marked in the margin with a time-base produced by an electrically maintained 500-d v tuning-fork Most of our results were obtained at 1,500 frames per sec Analysis of the velocity of flow was done both by measuring time taken to traverse successive millimetres of the artery, and by measuring the distance travelled during various periods of time

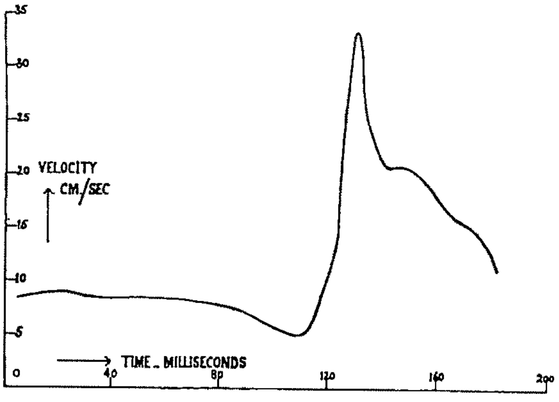

Fig 1. Changes in velocity during approximately one cardiac cycle

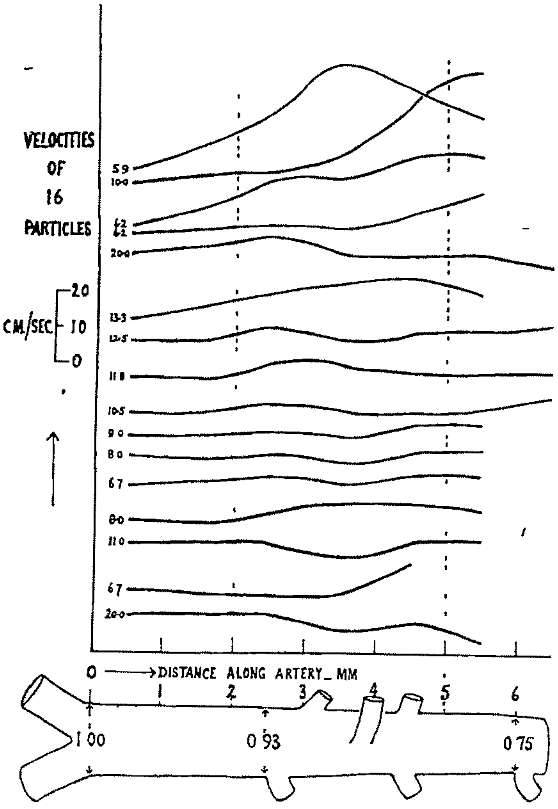

Fig 2 No constant change in velocity in relation to branching (between dotted lines) The initial velocity of each particle is shown against its curve

(10 msec during the phases of slow flow, and down to 2 msec where rapid changes were occurring ) The intervals between the arrival of each particle were recorded and a composite graph of the velocity changes throughout a cardiac cycle has been built up from the behaviour of successive oil globules (Fig 1) That the globules are not themselves significantly affecting the velocity is suggested by the fact that we have not detected any constant difference in the velocities of the smallest and largest globules in the series

Thus in the rabbit basilar artery it may be seen that there is a period of rapid acceleration lasting some 15–20 msec when the velocity increases from 5 to 33 cm per sec (40 cm per sec in another series) There is then a sharp fall to a plateau of some 20 cm per sec with probably a dicrotic notch intervening Thereafter the velocity declines throughout the rest of diastole The exact duration of the cardiac cycle could not be measured but was of the order of 200 msec (300 beats per minute)

That the acceleration or deceleration is not related to the conformation of the artery is shown by Fig 2 This shows that the changes in velocity of sixteen particles as they pass along bear no constant relation to the position of the branches

We consider it worthy of note that the velocity 'spike' is so sharp even after traversing the long, narrow and presumably elastic vertebral artery The end of this artery that we are observing is more than 100 diameters from the heart Furthermore, even at this distance the velocity at a given moment is dependent on its relation to cardiac systole and not to the presence of branching

It is perhaps also worth while considering what is meant when one refers to 'arterial velocity' Since the flow is pulsatile there is a maximum and a minimum velocity, and the latter may be a negative value in arteries (not this one apparently) where there is a brief phase of retrograde flow[3] An integrated mean velocity value must therefore be obtained for the whole cardiac cycle (from Fig 1 it is approximately 12 cm per sec )

This is non-specifically *linear* velocity , but since the flow is in addition streamlined, then what one might term a mean *laminar* velocity is further required if the volumetric rate of flow is to be calculated In our method the velocities obtained are presumably those of the more axial streams, depending on the size of the globule

It is thus difficult to calculate the volumetric rate of flow from our measurements of velocity Equally, we suggest that deductions concerning arterial velocity derived from volumetric rates have little significance

This cinematographic method, although expensive and not easily available, is the only one we know that can be used in an artery of this size It avoids instrumental interference and problems of inertia It may have further scope in investigating physiological problems

We are indebted to Kodak Research Laboratories for the cinematography This was done by Mr John Hadland, who also supplied certain technical details quoted [Aug 14.

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# SOME OBSERVATIONS ON BIOLOGICAL NOISE

By Dr P FATT and Dr. B. KATZ
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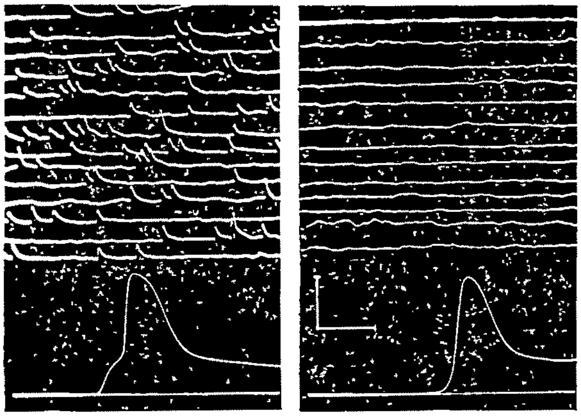
MOST biological reactions occur on such a large scale that they remain unaffected by the random fluctuations of participating molecules or energy quanta[1] There are, however, exceptions to this rule for example, visual threshold measurements depend upon fluctuations in the number of light quanta which strike the receptor cells[2] In this article observations are described which suggest that electrical random noise in fine nerve structures may produce important physiological effects Excitation of a nerve cell occurs when its membrane potential has suffered a sudden critical displacement[3] Owing to thermal agitation of ions, the resting potential of the cell does not remain at a constant level, but what we measure is, in fact, an average level subject to small statistical fluctuations If these fluctuations reach an amplitude of the order of millivolts, they may be expected to produce physiological responses The magnitude of the noise voltage fluctuation depends upon the cell size, and a simple calculation indicates that in a 100-$\mu$ muscle fibre the noise has an r m s voltage of only about 1 $\mu$V , but would approach 1 mV in a very fine nerve ending of, say, 0 1 $\mu$ diameter It is at the level of nerve terminals



An example of end-plate noise, recorded from a fibre of the musculus extensor longus dig IV of the frog upper portion, spontaneous potential changes recorded on a slow time base with high amplification, lower portion, response to a motor nerve impulse, recorded on a fast time base with low amplification (*a*) electrode inserted at an end-plate, (*b*) electrode 2 mm away, in the same muscle fibre Voltage and time scales represent 3 6 mV and 47 m sec for the upper part, and 50 mV and 2 m sec for the lower part

and nervous synapses that effects of ionic noise should be searched for, and the following observation appears, therefore, relevant

When a micro-electrode is inserted into the nerve-free part of a frog muscle fibre, a potential difference of about 90 mV is recorded across the fibre membrane[4] There is no sign of electric activity other than small disturbances due to the ordinary sources of noise in electrode and amplifier A very different picture is obtained when the electrode is inserted immediately under the motor nerve endings (see accompanying photographs)

There is local activity of a characteristic nature small action potentials of rapid rise and slow decay follow one another at random intervals These discharges occur in discrete sizes, indicative of a number of separately firing units These responses can be regarded as miniature 'end-plate' potentials[5], and, like the ordinary end-plate potential, they are abolished by curarine and increased in size and duration by prostigmine In fact, they are distinguished from the familiar end-plate potential only by their spontaneous and random occurrence and by their miniature size, which is about 1 per cent of the electric end-plate response to a motor nerve impulse The phenomenon may conveniently be called 'end-plate noise' It appears to be present at the majority of end-plates in frog muscle, but its average frequency varies greatly from fibre to fibre, between less than 1 per sec and about 100 per sec, at 20° C The rate of the discharge is greatly affected by physical changes—for example, small alterations of temperature, and of osmotic pressure, have a profound effect

It is very probable that, like the ordinary end-plate potential, these spontaneous sub-threshold effects are due to the release of small quantities of acetylcholine from motor nerve terminals, the difference being due to the activity of isolated terminal spots rather than to a synchronous discharge from the whole terminal apparatus It is known that acetylcholine is continually synthetized at the nerve endings[6], and the end-plate noise might perhaps be attributed to a bombardment of the motor end-plate by individual molecules of acetylcholine which escape from the nerve terminals This simple hypothesis, however, cannot be accepted, for the individual spontaneous responses are much too large to be produced by individual, or even small numbers of, acetylcholine molecules (the size of the responses is about 1 per cent of the full end-plate potential, and this is due to the action of at least $10^4$ molecules of acetylcholine, possibly much more) A more direct argument is as follows If the muscle is soaked in a solution containing $3 \times 10^{-7}$ *M* acetylcholine, the resting potential of the end-plate region is diminished by several millivolts, but the recurrence-rate of the end-plate noise remains unaltered Clearly, it cannot be due to molecular bombardment by escaping acetylcholine, for the rate of such a bombardment must be greatly increased in the presence of applied acetylcholine

We must therefore think of a local mechanism by which acetylcholine is released at random moments, in fairly large quantities, and the most plausible explanation is the occurrence of excitation at individual nerve terminals, evoked by spontaneous fluctuations of their membrane potential Once the membrane potential has been displaced sufficiently, local excitation occurs within a very brief interval of time, of the order of $10^{-4}$ sec, but it does not lead to a propagated impulse if the affected area is too small[7] The recurrence intervals between successive responses are relatively very long, and this suggests that, statistically, the response is a very improbable event (that is, the mean level of the underlying fluctuation is much less than the excitation threshold of the nerve terminals) Now, it is a characteristic property of such statistically improbable trigger-actions that their recurrence-rate is greatly affected by small changes of the threshold, or of the mean energy-level, of the system, and this may well explain the great differential sensitivity of our phenomenon to relatively small physical alterations (a 50 per cent increase in osmotic pressure, for example, produced a reversible increase in the rate of discharge from 2 per sec to 90 per sec)

It is possible that the phenomenon here described is of a much more widespread occurrence, and it will be worth looking for similar effects at fine nerve endings, sensory and synaptic, elsewhere in the nervous system While, in this particular case, local activity evoked by random changes in the motor nerve endings remained always well below the threshold of propagation, it appears that there are pathological conditions under which this phenomenon becomes exaggerated and leads to functional disorder—for example, the twitching during eserine poisoning[6] and under the influence of tetanus toxin[8] But the concept of local excitation being caused by peak voltages of membrane noise may be of wider application, and it is possible that such events play an important part in the production of spontaneous activity at neuronal synapses and sensory nerve endings

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# THE LONDON CONFERENCE ON OPTICAL INSTRUMENTS

THE London Conference on Optical Instruments, held at the Imperial College of Science and Technology during July 19–26, was timed to follow the meetings of the International Optical Commission, and was attended by nearly all the delegates of the latter. This helped to give a genuinely international flavour to a very successful series of meetings.

The declared object of the Conference was "to obtain a survey of modern practice and trends in the construction of actual instruments", but the proceedings also included symposia on the diffraction theory of optical instruments and on phase-contrast microscopy, and from the scientific point of view these were the most interesting sessions. Also noteworthy were the papers and discussions on reflecting microscopes, here the interest was mainly technological.

After the opening address by Sir Thomas Merton, president of the Conference, an account was given by Prof. S S Ballard of recent optical developments in the United States. Next, M A Maréchal (Paris) spoke about recent French researches on diffraction in optical instruments and showed interesting slides of particular cases of diffraction patterns, calculated on his integrating machine in the Institut d'Optique, associated with aberrations amounting to several wave-lengths, that is, of amounts not at present easy to deal with by more analytical methods.

Dr H H Hopkins described some investigations of his own into partial coherence and its connexion with microscopic resolution. Mr Barham gave an account of his joint paper with Dr Hopkins entitled "The Influence of Condenser Aperture on Microscopic Resolution".

Dr E Wolf then spoke about his recent work on the three-dimensional distribution of light in diffraction images near focus, this work has some important applications to the theory of telescopic star images. Dr E H Linfoot described in outline how diffraction theory could be applied to discuss the systematic errors inherent in phase contrast testing with a slit-source, his main result was that these errors do not impair the usefulness of the test for ordinary purposes.

The second day, July 20, was devoted to purely technical accounts of certain newly designed lenses for photography and for television. Mr R Kingslake (Eastman Kodak) described some recent developments of photographic objectives in the United States. Dr Hopkins spoke about the 'zoom' lenses on which he has been working recently, and Mr Warmisham (of Taylor, Taylor and Hobson, Ltd ) described a new $f/1$ objective with an 18° spherical field, intended primarily for radiology. A reception at the Royal Institution, followed by a discourse on phosphorescence by Prof E N da C Andrade, concluded the day.

July 21 was occupied by visits to the National Physical Laboratory and to other centres of optical activity.

On July 24 the proceedings began with a general survey by Dr R Barer entitled "Practical Requirements in a Reflecting Microscope". Dr A Bouwers (Delft) followed with an account of the concentric mirror microscopes recently put on the market by his firm. Finally, Mr D S Grey (Polaroid Corporation, U S A ) spoke on catadioptric microscopes.

In the afternoon, Prof Curtis, Dr G. R. Harrison and Mr C L Bausch (Massachusetts Institute of Technology), Dr E Ingelstam and Dr E Hulthén (Sweden), and Mr E Lind (University of Stockholm) read papers on various aspects of grating spectroscopy.

July 25 was mainly devoted to phase contrast microscopy. Papers were given by Prof F Scandone (Italy), Mr F W Cuckow, and Dr. M Françon (France), the last of whom described with rapidly and beautifully executed blackboard drawings his interesting devices for adapting standard microscopes to phase contrast work by the addition of an auxiliary optical system in front of the objective. Mr E Bergstrand (Sweden) discussed work on the velocity of light and the measurement of distances by a development of the Kerr cell method which uses crystal-controlled high-frequency fields. Mr J Guild (National Physical Laboratory) spoke on photometry. In the evening a large gathering at the Royal Astronomical Society's rooms in Burlington House received with enthusiasm a talk by Dr M A Ellison on "New Tools for Solar Physics", which included a showing of Menzel's exciting film, "Explosions in the Sun". A parallel gathering in the Royal Photographic Society's rooms heard Mr R McV Weston on the filming of living tissues with the microscope.

The morning of the concluding day, July 26, was occupied by three papers on spectrophotometry, the speakers being Prof S S Ballard (United States), Dr F Devignes (France), and Dr H W Thompson (Oxford). In the afternoon, talks on "The Modern Reflecting Telescope" and on a lens-mirror system for high-precision theodolites were given by Dr E H Linfoot and by Dr W Lotmar (Switzerland), respectively, the Astronomer Royal was in the chair.

Most of the papers were followed by well-informed discussions, and a tendency to refrain from mutual criticism, noticeable at the early meetings, was corrected later on at the urgent request of the Conference's efficient secretary, Prof L C Martin.

E H LINFOOT

# INDUSTRY AND THE UNIVERSITIES IN GREAT BRITAIN

THE report of the Conference on Industry and the Universities, organised by the Education and Industrial Research Committees of the Federation of British Industries last November* and at which both industry and all the universities of Great Britain were represented, as well as the British Institute of Management and the Administrative Staff College, has now been published, it includes an analysis of the forty-three replies received to a twelve-point questionnaire previously sent out to individual industrialists regarding their experience in employing university graduates or reasons for being unable to make use of them. These replies, which covered positions in industry for which graduates are recruited, opportunities and prospects, periods of training after recruitment, qualities and characteristics sought by industry in its graduate recruits and comments on the current standard of graduates and the success of the universities in educating men for industry, were summarized and circulated to those attending the Conference and provided a basis for discussion.

Sir Hubert Henderson, opening the discussion on behalf of the universities, commented that the general tone of the replies showed that there is already a much greater appreciation of the point of view of the universities than might have been found a short time ago He endorsed Sir Charles Tennyson's observation that the prime function of the universities is to maintain and advance the standards of knowledge, and said that scholarship and research must be their dominant objectives even the essential function of teaching would suffer if there were an attempt to subordinate the primary functions of maintaining and advancing the standard of knowledge to what was intended to be more efficient teaching Sir Hubert thought, too, that the distinction between fundamental and applied knowledge can be overstressed, he knew of nothing more important in the history of the development of human thought than the advances which have been made by a constant interplay between abstract analysis and the attempts to solve particular concrete problems Nevertheless, he agreed that things that are in the nature of techniques cannot profitably be taught in a university

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* Report of the Conference on Industry and the Universities, organised by the FBI Education and Industrial Research Committees and held at Ashorne Hill, Leamington Spa, 25 to 28 November 1949 Pp 94 (London Federation of British Industries, 1950 ) 3s

The report of the Conference includes brief summary reports from the discussion groups, which considered postgraduate studies and research, education for management, the supply of science teachers for schools, the interpretation of industry within the universities, and the development of closer relationships between industry and the universities There was also some general discussion on the first three of these subjects, and the general feeling of the Conference was in favour of the Federation of British Industries doing what it can to see that the seriousness of the position regarding science masters is fully realized by the proper authorities There was a decided cleavage of opinion as to whether management studies are appropriate for a university, most industrialists remaining neutral, but the Conference was agreed as to the desirability of not labelling courses so as to suggest that they represent the one and only approach to management

At the third session, which considered industry's requirements of scientific workers and technologists and their education and training, Sir Arthur Fleming said that he preferred to absorb the graduate when he had gained his first degree, but urged the importance of giving the graduate the greatest possible amount of responsibility when he enters industry Sir Arthur advocated at least two years training in works departments for the technologist Wing-Commander T. R Cave-Browne-Cave stressed the importance of personal qualities and of realistic personal touch between industry and universities Prof P. M S Blackett doubted the value of management courses and of vacation work, vacations offer invaluable opportunities of building character in other ways, and he pointed out that the universities can claim that, whether or not they produce the best men, a large and increasing proportion of the best of the youth of the country goes to the university and, when there, wishes to study a large variety of subjects

Lord Simon of Wythenshawe presided over the fourth session, which dealt with industry's requirements of arts graduates, and the discussion was opened by Sir Humphrey Gale, who put, first, character, personality and power of leadership and, next, ability to write and speak clearly and to express succinctly the essentials of any given situation Selection of arts graduates by industry requires more exacting methods than the selection of technologists, and he thought that appropriate use of such graduates might relieve technologists of marginal administrative work and reduce requirements of technologists Lord Eustace Percy stressed the importance of the problem and the need not only to experiment with selection methods but also for the universities themselves to experiment both with different methods of teaching in the older established arts courses and with newer arts courses Miss Marjorie Hayward said that she was encouraged by the importance attached to personal qualities but referred to the difficulties of placing arts graduates in industry It was clear that this problem caused some concern to the Conference, and that it would be difficult to place the increased number of arts graduates of average ability unless industry could arrange training and apprenticeship schemes for them

At the fifth session, Dr Percy Dunsheath, Mr C Morris and Dr A E Trueman attempted to summarize the preceding discussions and conclusions The first two appealed for the fullest possible understanding between industry and the universities on all the important matters raised, and Dr Trueman referred to the investigations into the supply and demand of scientific workers and technologists being undertaken by the Hankey Committee for the Ministry of Labour and the necessity of avoiding any steps likely to produce heavy graduate unemployment or misemployment He urged that the universities should not be pressed to expand further, until they have had time to provide accommodation for the present increased numbers

Particular points calling for action, which emerged at the Conference, were that a much greater supply of information by industry on its structure and its requirements of graduates should be made available to the universities and schools, and that industrialists should be encouraged to take a greater interest in the universities through their governing bodies, advisory councils and appointments boards, and, conversely, that university staffs should become better acquainted with industry In regard to the first, information about careers in the various branches of industry and in individual firms is needed, and it was suggested that the Federation of British Industries could help by supplying such information The interpretation of industry to the universities could be improved by temporary exchanges of industrial and university research staffs on an individual basis, and industry might further help by arranging short refresher and background courses for university professors and lecturers The value of vacation courses was fully recognized, for arts students as well as for scientific workers and technologists, but not to the exclusion of other vacation activities Increased flexibility in the postgraduate courses offered by the universities was suggested, and it was also proposed that the Federation of British Industries, in conjunction with the University Grants Committee, should organise a small team under the auspices of the Anglo-American Productivity Council to visit the United States for studying the relationship between American universities and industry, in order to see whether, and, if so, to what extent, this relationship is connected with the high productivity of American industry Although the Conference considered that the shortage of science graduates would persist for several years, whether the position would thereafter improve remains uncertain, and industry should examine further the possibility of effecting economies in its use of science graduates

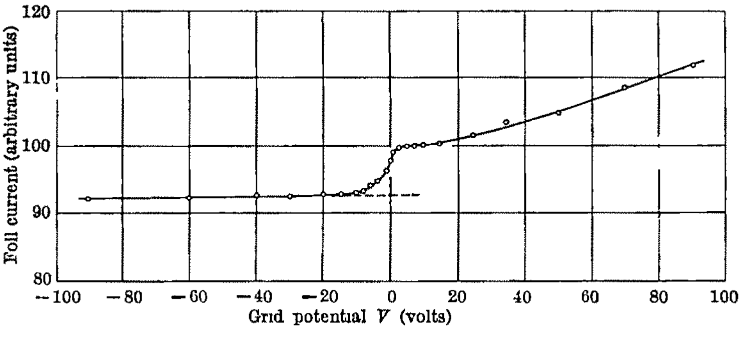
# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## An Absolute Method for Measuring the Activity of Radioactive Isotopes

RADIOACTIVE isotopes are, at the present time, being used in a wide variety of scientific investigations. Thus the development of accurate methods for the assay of these substances is of considerable importance. The three methods in common use involve the Geiger counter, the ionization chamber and the micro-calorimeter, and, although simple in principle, they are quite complicated in practice. It therefore seemed worth while to investigate the possibilities of a new method based on the fact that a flow of β-particles is equivalent to a current. In the case of a pure β-emitting isotope, 3.7 × $10^7$ β-particles are emitted per second per millicurie (by definition), and this is equivalent to a current of 5.93 × $10^{-12}$ amp. If the isotope is deposited on a thin foil, mounted in a vacuum to eliminate gas ionization, and an electric field is applied to prevent slow secondary electrons from escaping, then the current flowing from the foil should be a direct measure of the total activity. The accurate measurement of a current in the region of $10^{-12}$ amp is quite feasible, so that in principle it should be possible to measure radioactivity in this way. A preliminary investigation of the method has been completed, and the present communication gives a brief account of the results so far obtained, with particular reference to the effects caused by secondary emission and by ionization of the residual gas.

About 1 millicurie of phosphorus-32, deposited on a 0.0005-in. aluminium foil, was used in the experiment. The foil was completely surrounded by an open-mesh wire grid, which in turn was contained in an earthed metal box evacuated to a pressure of about 5 × $10^{-5}$ mm mercury. The foil was supported by means of a light wire frame and remained within a few millivolts of earth potential, the current flowing from it being measured with the usual arrangement of high resistance, electrometer valve, and backing-off voltage. By applying a variable potential to the grid, it was possible to investigate the effect of secondary electrons produced when the β-particles emerged from the foil and when they reached the inside wall of the metal box. The results obtained are shown in the accompanying graph, where the positive current flowing from the foil to earth is plotted as a function of the potential ($V$) applied to the grid.



With a negative voltage applied to the grid, secondary electrons produced at the surface of the foil were repelled back to the foil, and those produced at the surface of the box were repelled back to the box. The shape of the curve between − 20 V and + 5 V is caused by the transition from a state in which no secondaries escaped to one in which all secondaries were collected by the grid, the intermediate value of current at $V = 0$ being due to the interception, by the foil, of some of the secondaries from the box. The curve shows that most of the secondaries were liberated with kinetic energies of only a few electron volts. At large negative values of $V$ the curve has a slight slope which can be attributed to the repulsion of very slow β-particles. The intercept of the extrapolation of this part of the curve with the current axis at $V = 0$ gives the total number of β-particles produced per second.

The increased current observed at high positive values of $V$ was caused by gas ionization. With positive values of $V$ an electron, formed by ionization of the residual gas, would, in general, describe a very long oscillatory path before finally being collected by the grid. This follows from the facts that (*a*) such an electron could not reach either the foil or the box, because it starts at rest with too little potential energy, and that (*b*) it may pass through the grid many times before striking it, since the grid has a very open mesh. For values of $V$ greater than the ionization potential of the residual gas, such electrons would cause further ionization, and the effect would be cumulative. In addition, the greater the value of $V$ the greater would be the total ionization produced as a result of the formation of one primary electron. The curve is flat between $V = + 4$ and $V = + 12$ and then starts to rise, in agreement with the values of the ionization potentials of $N_2$, $O_2$ and $H_2O$ (15.5, 12.5 and 12.6 volts, respectively). Furthermore, the slope of the curve in the region $V$ greater than + 12 was found to increase approximately linearly with increasing gas pressure, whereas the rest of the curve was not affected.

These results show that the number of secondary electrons produced was small (about 7 per cent of the number of β-particles) and that most of them emerged with very little kinetic energy. These facts suggest that the method could be developed to give good absolute accuracy. In the present series of experiments no attempt was made to obtain good absolute accuracy, as the main purpose was the investigation of the possibilities of the method. The actual value found for the activity of the sample used was 0.82 millicurie, compared with the value 0.91 millicurie quoted by the Atomic Energy Research Establishment, Harwell.

An attempt is now being made to improve the accuracy of the method. This requires the application of corrections (*a*) for the absorption of β-particles by the foil and its supporting structure, and (*b*) for the emission of secondary electrons by the grid. Both these corrections can be made small, by means of suitable experimental conditions. In addition, it is necessary to measure a current of about $10^{-12}$ amp with an accuracy of about ± 2 per cent, and a suitable method is being developed.

Measurements of other radioactive isotopes are also planned. In the case of ($\beta + \gamma$)-emitters, the measured current would include fast electrons produced by internal conversion, and a knowledge of the internal conversion coefficient would then be required before the activity of the source could be determined.

Since this work was started, Gross and Failla[1] have described experiments along similar lines, in which a magnetic field was used to prevent the escape of secondary electrons.

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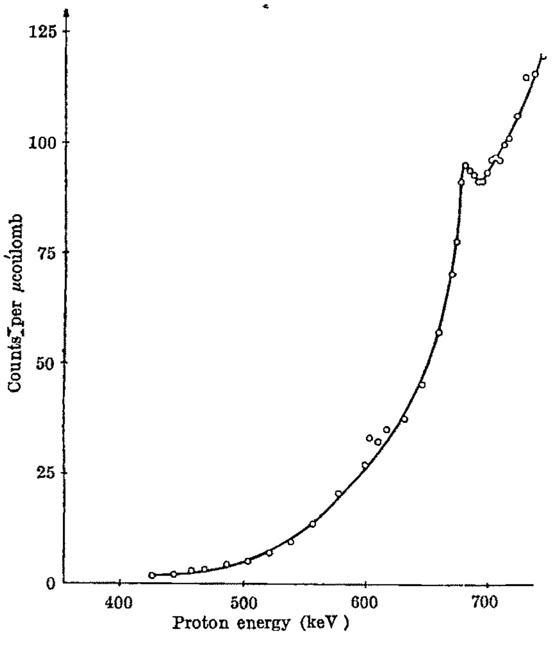
[1] Gross, W., and Failla, G., *Bull. Amer. Phys. Soc.*, 25, No. 3, 18 (1950).

## Thin-Target Yield of $O^{18}(p,\alpha)N^{15}$

THIN targets of oxygen-18, prepared by bombarding silver plates in an electromagnetic isotope separator at mass number 20 with water vapour in the ion source, were bombarded with protons (400–750 keV.) in a Cockcroft–Walton accelerator. The thin-target yield of $\alpha$-particles within a cone of top angle 17° at 90° to the incident beam was studied with a proportional counter, the window thickness of which was such that only $\alpha$-particles of range greater than 1.5 cm. in air could be detected. Gamma-rays had no influence upon the counter. The measured yield curve is given in the accompanying graph.

Five hours of proton bombardment did not change the yield beyond the limits of experimental accuracy. Range measurements showed that the energy of the $\alpha$-particles corresponded to the $Q$-value of the reaction $O^{18}(p,\alpha)N^{15}$ reported in the literature[1,2].

As the yield curve shows a resonance at about 680 keV., the range of the $\alpha$-particles at resonant proton energy was specially studied to make sure that the resonance did belong to the $O^{18}(p,\alpha)N^{15}$ reaction. The small irregularity at 600 keV. will be further investigated.



Thin-target yield curve for $O^{18}(p,\alpha)N^{15}$ at 90°

The voltage scale was calibrated at one point, 446 keV., with the $Li^7(p,\gamma)$ reaction on a separated lithium-7 target.

We wish to express our thanks to Messrs. S. Thulin and I. Bergstrom for preparing the targets in the isotope separator.

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[1] Burcham, W. E., and Smith, C. L., *Nature*, 143, 795 (1939).

[2] Freeman, J. M., *Proc. Phys. Soc.*, A, 63, 668 (1950).

## Photo-oxidation of Water by Ceric Ions

IN view of the importance which is attached to the photochemical oxidation of water in the understanding of the process of photosynthesis[1], we would like to submit a scheme, which, as we show, agrees well with the data reported in the literature and our own experience in this field of research. Weiss and Porret[2] were the first to investigate the photo-oxidation by ceric ions (a qualitative observation to this effect had been made by Baur[3] in 1908). A more detailed study was carried out by Heidt and Smith[4]. The latter assumed the formation of an active ceric dimer being deactivated by cerous ions to account for their otherwise inexplicable observations as to dependence of the quantum yield on the concentration of ceric and cerous ions in solution. Spectrophotometric measurements carried out by us (to be published later) show conclusively that there is no dimer formation, and that in ceric perchlorate solutions in normal perchloric acid approximately 92 per cent of the ceric ion is present as the ion-pair complex $Ce^{4+}OH^-$. On the other hand, Heidt and Smith's kinetic results can be accounted for qualitatively and quantitatively on the basis of the following reaction scheme, which makes it also possible to explain in quantitative terms why in the case of ferric ions the quantum yield should be much smaller, and therefore under normal laboratory conditions scarcely measurable; as in our work on photo-initiated polymerization[5,6] and oxidation[7], we consider the primary step as an electron-transfer excitation with the ion-pair complex as the active species. This is the scheme we suggest:

$$(1)\quad Ce^{4+}OH^- \underset{k_d}{\overset{k_\varepsilon I}{\rightleftharpoons}} Ce^{3+}OH$$

$$(2)\quad Ce^{3+}OH \xrightarrow{k_s} Ce^{3+} + OH$$

$$(3)\quad Ce^{3+} + OH \xrightarrow{k_0} Ce^{4+} + OH^-$$

$$(4)\quad Ce^{4+}OH^- + OH \xrightarrow{k_1} Ce^{3+} + H_2O_2$$

(OH radical a reducing species!)

$$(5)\quad 2Ce^{4+}OH^- + H_2O_2 \longrightarrow 2HOH + 2Ce^{3+} + O_2\uparrow$$

not rate-determining

From stationary-state kinetics we obtain

$$[Ce^{3+}OH] = \frac{k_\varepsilon I}{k_d + k_s}$$

$$[OH] = \frac{k_s k_\varepsilon I}{(k_d + k_s)\,(k_0[Ce^{3+}] + k_1\,[Ce^{4}OH^-])}.$$

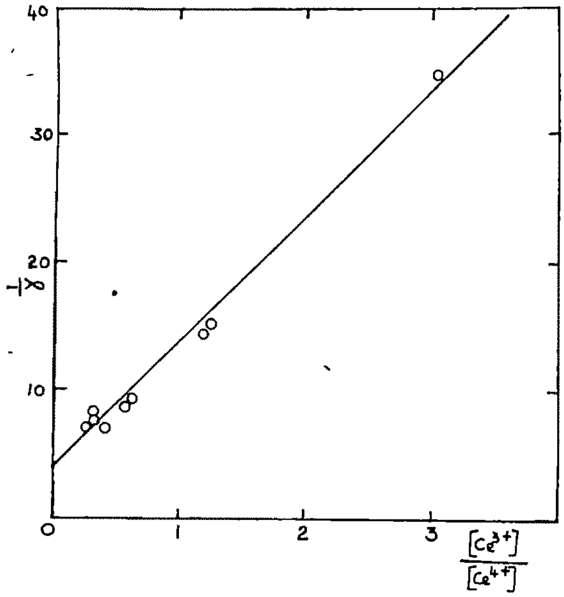
The net quantum yield with regard to $Ce^{3}$-ion formation is

$$\gamma_{net} = \frac{dCe^{3+}}{dt}\, k_{s}I = \frac{4k_s}{k_d + k_s} \times \frac{k_1[Ce^{4+}OH^-]}{k_0[Ce^{3+}] + k_1[Ce^{4+}OH^-]}$$

The maximum quantum yield is $4k_s/(k_d + k_s)$ The experimental observations would lead to a value of $\sim 5 \times 10^{-2}$ for $k_s/(k_d + k_s)$, that is, of a similar order to that observed for $Fe^{3+}OH^-$ It is obvious that

$$\frac{dO_2}{dt} = \frac{1}{4}\,\frac{dCe^{3+}}{dt}$$

When the results obtained by Heidt and Smith are utilized for a plot of $1/\gamma$ against the ratio $[Ce^{3+}]/[Ce^{4+}]$, a straight line is obtained leading to values of $\sim 5 \times 10^{-2}$ for $k_s/(k_d + k_s)$ and 10 for $k_0/k_1$ This is shown in the accompanying graph Heidt and Smith (*loc cit*) plotted instead the quantum yield against $[Ce^{4+}]/[Ce^{3+}]$ and obtained a hyperbola It must be understood that, at very low ceric ion concentrations (less than $\sim 2 \times 10^{-3}$ *M*), hydroxyl radicals would react with impurities in the distilled water Under these conditions the maximum quantum yield will be $k_s/(k_d + k_s) \simeq 5 \times 10^{-2}$



We note that both reactions (3) and (4) are considerably exothermic The ionization potential of cerous ion in aqueous solution may be estimated as $\sim$ 110 k cal (from the oxidation-reduction potential and the expected entropy change) With the values obtained by Evans and Uri[8], the heat of the reaction $Ce^{3+} + OH \rightarrow Ce^{4+} + OH^-$ and $Ce^{4+}OH^- + OH \rightarrow Ce^{3+} + H_2O_2$ may be calculated as $\sim$ 25 k cal and $\sim$ 20 k cal respectively The experimental observations show that the respective rate constants differ at the most by one power of 10, which in energy terms means a difference as small as 1 5 k cal in the activation energy, assuming similar temperature-independent factors (which considerations of the entropy of activation would not make unlikely)

We would expect that this action of hydroxyl radicals which we discuss above will be found to be important in many reaction systems in aqueous solution The relative rates of

$$Fe^{3+}OH^- + OH \rightarrow Fe^{2+} + H_2O_2$$
$$\text{and } Fe^{2+} + OH \rightarrow Fe^{3+} + OH^-$$

may well account for the high light-intensities required for the measurement of oxygen evolution from water and $Fe^{3+}OH^-$ complex

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[2] Weiss and Porret, *Nature*, 139, 1019 (1937)

[3] Baur, *Z phys Chem*, 63, 683 (1908)

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## Photochemical Conversion of Stilbene to Phenanthrene

SMAKULA[1] noticed that irradiation of solutions of *cis*-stilbene with ultra-violet light caused the formation of material different from *trans*-stilbene, and this observation was confirmed by Lewis, Magel and Lipkin[2] To our knowledge, the nature of this photochemical reaction has never been elucidated, nor have any products been identified

We have succeeded in isolating a single product in good yield from cyclohexane solutions of *trans*-stilbene irradiated with ultra-violet light, and have unequivocally identified the product as phenanthrene

Eventually we will present more extensive information concerning this reaction and its occurrence with *cis*-stilbene and $\alpha$-phenylcinnamic acid

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[1] Smakula, *Z physik Chem*, B, 25, 90 (1934)

[2] Lewis, Magel and Lipkin, *J Amer Chem Soc*, 62, 2973 (1940)

## Ferric Soaps as Catalysts for Vinyl Polymerization

IN the course of work on the effect of metallic soaps on polymerization[1], we found ferric oleate to possess a fairly strong catalytic power for the polymerization of styrene and methyl methacrylate As the problem presents some very unusual features, a detailed account of which will be published elsewhere, we report here some salient features about this new catalyst

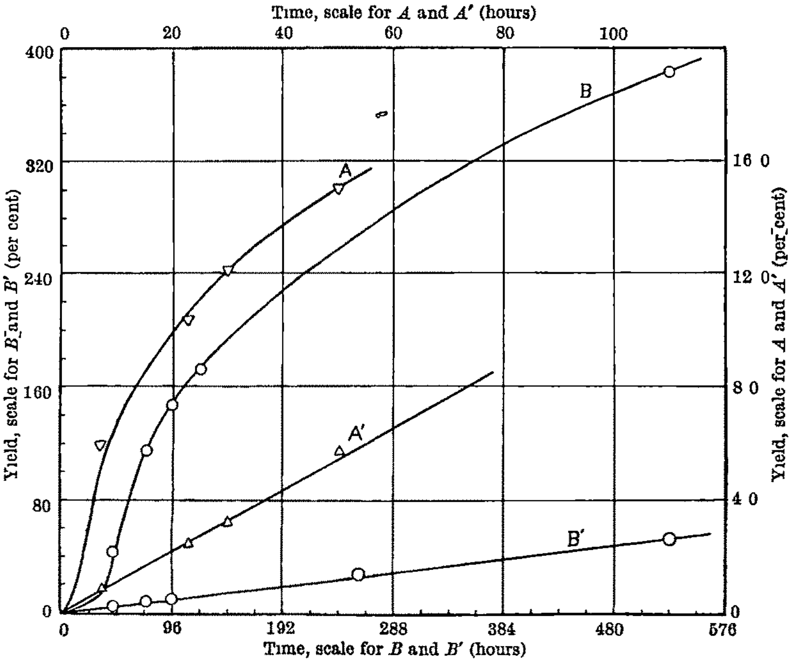
It might be suspected that some spurious peroxidic impurities likely to be present in the oleic acid were responsible for this catalytic property This, however, was disproved by the following experiments Ferric oleate solution in benzene was heated *in vacuo* at 80° C for several days in order to decompose any peroxide present, and this pretreated solution was found to retain the power to catalyse the polymerization of styrene Further, specially purified ferric laurate and ferric stearate were successfully used as catalysts in these polymerization experiments Lastly, oleic acid and stearic acid from which the soaps were prepared were found to have practically no effect on polymerization of styrene Two typical experimental curves are shown in the accompanying graph

Systematic experiments have been made to find the variation of the initial speed of polymerization of styrene with the concentrations of monomer and catalysts, and the results show that the initial velocity depends roughly on a power of monomer concentration lying between 3 and 4 · The velocity of polymerization rose rapidly with increase in catalyst concentration, but no simple relation between them could be found

The dependence of the degree of polymerization on the above factors was investigated It has been found that it is inversely proportional to the square root of the catalyst concentration as in free-radical polymerization, but varied unexpectedly with the reciprocal of the monomer concentration This last effect, that at the same catalyst concentration dilute solutions of monomer produce a higher degree of polymerization of the polymer, is very difficult to explain and distinguishes this catalyst from all other hitherto known types of catalysts The accompanying table illustrates this point for styrene polymerization in benzene solution at 45° C catalysed by ferric laurate (2 16 × $10^{-3}$ moles per litre)

It is also observed that the catalytic power relative to the uncatalysed thermal reaction under the same experimental conditions is more prominent the lower the temperature, which probably indicates a lower energy of activation for the catalysed reaction An idea of the relative rates at 35° and 60 4° C can be obtained from the accompanying graph

Though the above features are in sharp contrast to the free radical type polymerization, we have, however, verified that the ferric oleate catalysed polymerization of methyl methacrylate is susceptible to inhibition by benzoquinone, a feature generally considered to be characteristic of free radical polymerization Further, no reduction of the ferric soap is involved, as the system fails to give a positive test for ferrous iron at the end of the polymerization run



Curve *A*, polymerization of styrene in bulk at 60 4° C with 0 025 mole per cent ferric stearate as catalyst, *A′* is same as *A* without catalyst Curve *B*, polymerization of styrene in bulk at 35° C with 0 026 mole per cent ferric oleate as catalyst, *B′* is same as *B* without catalyst

| Monomer concentration [*M*] | | [$\eta$] | Degree of polymerization (D P )* | D P × [*M*] |
|---|---|---|---|---|
| (Bulk) | 8 64 molar | 1 85 | 6,300 | 54 4 × $10^3$ |
| (Benzene soln ) | 6 48 molar | 2 23 | 8,140 | 52 7 × $10^3$ |
| ,, | 4 32 molar | 3 25 | 13 770 | 59 5 × $10^3$ |

*Calculated from equation[2] $[\eta] = KmM^{a}$, $Km = 1\ 2 \times 10^{-4}$, $a = 0\ 72$

These results, which are fairly reproducible, are difficult to reconcile with a polar mechanism[3], as it is known that even strong Friedel–Crafts catalysts fail to initiate polymerization of methyl methacrylate[4] Hence the question of classification of this type of catalyst into any of the two conventional types must remain open pending further investigation

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[1] Sen, J N, Sengupta, R, and Palit, S R, *J Ind Chem Soc*, 26, 385 (1949)

[2] D'Alelio, G F, "Experimental Plastics and Synthetic Resins", 71 (John Wiley and Sons, Inc, 1946)

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## Removal of Girard Reagent 'T' from Biological Ketonic Fractions not easily Extracted by Organic Solvents

THE isolation of the ketonic fraction of biological materials by the use of trimethylcarbohydrazidomethylammonium chloride (reagent 'T') has been described by Girard and Sandulesco[1] Essentially, the method utilizes the formation of water-soluble, ether-insoluble hydrazones between the ketonic bodies and the reagent, from which the non-ketonic fraction is removed by repeated ether extraction This complex compound is then decomposed by treatment with mineral acid, and the resulting ketonic fraction extracted with ether

The method is most satisfactory so long as the ketonic bodies are reasonably extractable by ether or another organic solvent immiscible with water However, the study of the ketonic fractions from certain urinary and adrenal extracts in this Laboratory has shown that portion to be very readily soluble in water or alcoholic solvents, and not very easily recoverable by extraction with ether, chloroform, benzene, ethyl acetate, etc Consequently, in order to prevent toxicity and interference by Girard reagent 'T' in the bio-assay of these extracts for their power to inhibit the growth of *S*37 transplants and induced tumours in mice and rats, the following method has been devised to remove the compound.

The aqueous solution remaining after removal of the non-ketonic fraction, by repeated extraction with various solvents, is acidified to $0 \cdot 5$–$1 \cdot 0$ $N$ with hydrochloric or sulphuric acid, thereby decomposing the ketone-reagent 'T' hydrazones on standing or with gentle warming. To this aqueous solution is added approximately 2–3 times its volume of absolute methanol, followed by approximately 15–20 times its volume or more of ether. The minimum volume of methanol is added in order to ensure a one-phase system, and the maximum amount of ether without separation into two layers. Under these conditions, the Girard reagent 'T' is precipitated on standing and may be filtered off; any material remaining on the precipitate may be washed off by cold methanol, and filtered into a good volume of ether, when the small quantity of reagent 'T' dissolved by the methanol is precipitated, while the ketonic bodies present in small concentration are sufficiently soluble in the large volume of the methanol/ether mixture.

The total ether/methanol/water solution may then be concentrated under reduced pressure to a suitable residue, when the process may be repeated if necessary until most, if not all, of the Girard reagent 'T' is removed.

This separation has been found to be very useful in dealing with the small quantities of total solids from urinary and adrenal extracts, particularly as a comparatively large amount of reagent 'T' is recommended for a good separation of the ketonic bodies. By this method, for example, these extremely water-soluble ketonic fractions, extractable by ether with very great difficulty, can be bio-assayed without interference from the separating reagent, and it is hoped that it may be equally of value to workers of other fields who use this very convenient fractionation.

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[1] Girard and Sandulesco, *Helv. Chem. Acta*, **19**, 1095 (1936).

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## Possible *f*-Shell Covalency in the Actinide Elements

UNDER the above title, Glueckauf and McKay[1] have presented a discussion, based in part on data of Katzin and Sullivan[2], in which they suggest that the co-ordination of nitrate groups, and the extraction of uranyl, neptunyl and plutonyl nitrates into organic solvents, are phenomena different in kind from those found with elements lower in the periodic table, and are therefore indicative of possible *f*-shell covalency. I believe that the co-ordination of nitrate by uranyl ion is neither unique nor different in kind from that found lower in the Periodic Table, and in particular with a transition element such as cobalt.

Katzin and Gebert[3] have shown that cobaltous nitrate, dissolved in an organic solvent such as acetone or tertiary butyl alcohol, is undissociated, and probably conforms to the formula $Co(NO_3)_2 \cdot 4X$, where $X$ represents a solvent group. Furthermore, the presence of nitrate ion in the solution results in formation of a trinitrato-cobalt (II) complex. Ternary phase studies, similar to those by Katzin and Sullivan[2] on the uranyl nitrate – water – solvent system, have been made on the systems cobalt nitrate – water – acetone and cobalt nitrate – water – tertiary butyl alcohol by Katzin and Ferraro[4]. These have demonstrated that the behaviour of cobalt nitrate in these systems is essentially like that found for uranyl nitrate. Spectrophotometric data on the changes induced in the light absorption of the nitrate group by various metal ions in tertiary butyl alcohol solution[5] show that manganous, cobaltous, nickelous and cupric nitrates exhibit striking and characteristic modifications of the nitrate group absorption, which can be traced to formation of the undissociated salt. In addition, further investigation of cupric nitrate[6] shows formation of trinitrato complex in acetone solution. Although the effects on the spectrum were not as marked as for the salts with incomplete *d*-shells, lithium, magnesium, calcium, aluminum, zinc, cadmium and thorium nitrates, as well as nitric acid, in tertiary butyl alcohol solution, showed modifications of the nitrate ion absorption from that in water[5]. Von Halban[7] and co-workers have studied the nitric acid case in detail, showing the change to be due to formation of undissociated unhydrated $HNO_3$, and there seems justification for assuming that all the spectral alterations noted reflect formation of undissociated molecules. Even in aqueous solution, the alkaline earth nitrates give evidence of partial association[8].

In summary, then, rather than perceiving unique properties, one is struck by the similarity of behaviour of uranyl nitrate and the simple divalent metal nitrates, in particular, those of the transition elements. Furthermore, there is no evidence in any of our data for true covalency; all the complexes formed are by all criteria of the 'ionic' type. The behaviour in organic solution, common to uranyl nitrate and nitrates of the divalent transition elements lower in the periodic table, has led me to a generalized picture of the solution processes of salts in electron-donor solvents, including water, which it is hoped to present in detail at another time.

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DR. KATZIN bases his argument chiefly on certain similarities in the behaviour of uranyl nitrate and the divalent transition metal nitrates in acetone and tertiary butyl alcohol. In ethers, however, the differences in solubility are extraordinarily large, and this forms one of our main pieces of evidence. It implies that the free energy of transference from water to ether is some 10 k.cal./mol. greater for uranyl than for, say, cobalt nitrate.

Such a high energy suggests that undissociated uranyl nitrate, perhaps unlike most other nitrates, may exist in covalent rather than ion-pair form Indeed, the mere fact that the properties in question are most highly developed for the very large uranyl ion would seem to rule out any explanation in terms of ion-pairs alone

As the title of our note made clear, we consider *f*-shell covalency a possibility rather than a certainty, and we hope that further evidence will be forthcoming from other lines of approach For the present, the conclusion reached will depend on the relative weight given to different lines of argument, and in spite of Katzin's comments we still favour our original suggestion

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## Mode of Action of Specific Solvents for Bituminous Coals

IT has been reported[1] that conditions of solution such as coal/solvent ratio and successive treatment with solvent have a considerable influence on the yield of extract obtained when coals of low rank are treated with specific solvents[2] Further work has shown that these effects, and others since observed, can largely be ascribed to mechanical causes, and they will therefore not be discussed in detail. Four points of interest have, however, come to light

(1) Mechanical shaking, although desirable in order to increase the *rate* of solution, has a markedly adverse effect on the yield of soluble material which can be obtained in a single treatment

(2) By appropriate methods a maximum yield of soluble matter can be obtained, which depends only upon the type of coal, the solvent and the temperature of treatment This limiting yield may be reached by extended treatment (successive extraction) in spite of the adverse effect of shaking mentioned in note (1)

(3) With the lowest-rank coals (the internal colloidal structure of which is readily accessible to liquids), and one or two of the best solvents, the concentration of dissolved material appears to be the same both in the solvent imbibed into the micropores and in the bulk solution outside the coal particles This, however, is only strictly true under ideal conditions of mechanical treatment It is considered to represent the fundamental primary equilibrium

(4) An important departure from the behaviour described in note (3) is observed when the bulk solution concentration exceeds a certain value, for example, approximately 8 gm /100 c c in the case of ethylene diamine, the concentration in the bulk solution then appears to increase at the expense of that in the micropores, and in consequence the recoverable extract or apparent yield increases This effect is ascribed to aggregation of the soluble units in the bulk solution Evidence of such aggregation is shown independently by the tendency of strong solutions rapidly to form surface skins and to throw down sludge, whereas dilute solutions are stable almost indefinitely

The function of the solvent in reversing the effect of ageing has already been pointed out[2] If imbibed solvent can loosen up the colloidal structure of the solid sufficiently, it is probable that controlling factors more akin to equilibrium solubility come into play Up to a volume imbibition ratio of approximately 2, whether the (specific) solvent or the coal is varied, extraction yield shows a striking proportionality to the imbibition ratio But the greater the imbibition the greater become the differences between the yields obtained with different solvents at a given swelling-level, scatter increases, and a departure from the average linear proportionality is also observed at very high imbibition ratios In this upper range, it is probable (and supported by independent evidence) that the yield of extract is determined chiefly by the size distribution of colloidal units in the coal in relation to the largest unit which is appreciably soluble (in the equilibrium sense), in the lower range, on the contrary, a large measure of control must be exerted by difficulties of disengagement, that is, by what may be termed a micellar sieve mechanism

The temperature coefficient of extraction yield varies to a limited extent with the rank of coal The property found most suitable for characterizing rank in this connexion is the amount of solvent imbibed at room temperature When the volume imbibition ratio exceeds unity, the value of the temperature coefficient ceases to change further with rank This observation is probably to be explained in terms of a coefficient fundamentally independent of rank but nevertheless influenced by a barrier to solution imposed by the sieve mechanism mentioned in the previous paragraph. It is probable that the constant value of the temperature coefficient can be used, on the lines indicated by Brønsted[3], Schulz[4] and Gee[5], to deduce a size distribution for the unit particles of soluble material The form of the relation between extraction yield (in ethylene diamine) and temperature, for a number of coals with which the imbibition ratio exceeds unity, indicates, if interpreted in this way, a modal size which is constant over a considerable range of rank, but in the present state of knowledge it is impossible to calculate the absolute magnitude of this parameter The value of the modal size is of interest in connexion with estimates of the average colloidal unit size derived from porosity and heat of wetting (internal surface) measurements by Bangham[6] and co-workers, of crystallite sizes derived by Riley[7] and co-workers, and of molecular weights determined by cryoscopic methods[8]

A fuller account of this work will be published elsewhere

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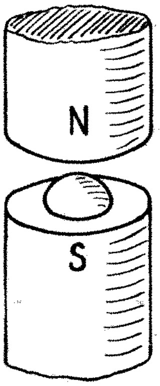
## Use of a Magnetic Field in Detecting Corrosion Currents

WHEN a drop of dilute potassium chloride solution is placed on a horizontal sheet of freshly abraded iron, corrosion occurs at the centre of the drop, but the periphery remains unattacked[1]. This phenomenon is commonly ascribed to electric currents flowing between the (well-aerated) peripheral zone as cathode and the (less well-aerated) central zone as anode. In several analogous cases, such as partly immersed plates of metal, the electric currents have been measured and found to be sufficiently strong to account for the whole of the corrosion observed[2]. The study of the currents flowing in drops has been somewhat less direct, and the following experiment may possess general interest.



A powerful electromagnet is provided with two iron pole-pieces, the air gap being a few millimetres across (see diagram). A drop of potassium chloride, or similar salt solution, placed on the lower surface, is found to rotate when the magnetic field is turned on; the direction of rotation changes from clockwise to counter-clockwise when the polarity of the field is reversed. The rotation is best observed by the use of dark-background illumination; the light (suitably filtered to eliminate heat rays) arrives from the left, and the observations are made from the front by means of a lens or microscope. The observation of the movement depends upon the presence of the small dust particles commonly present in water which has not been specially prepared.

From the velocity of rotation, a rough estimate of the strength of the current flowing can be obtained in the following way. A drop is placed in the gap of the magnet, in such a way that its centre rests on a small circular electrode and the periphery on a ring electrode of platinum wire. An E.M.F. is applied between the two electrodes and the current flowing is measured directly. The relation between current and rotation velocity can thus be obtained, and the results used for obtaining the strength of the current flowing in the main experiments.

In other experiments, arrangements were made for the replacement of air by nitrogen. This replacement caused the rotation of the drop to become very much slower—confirming the explanation given above.

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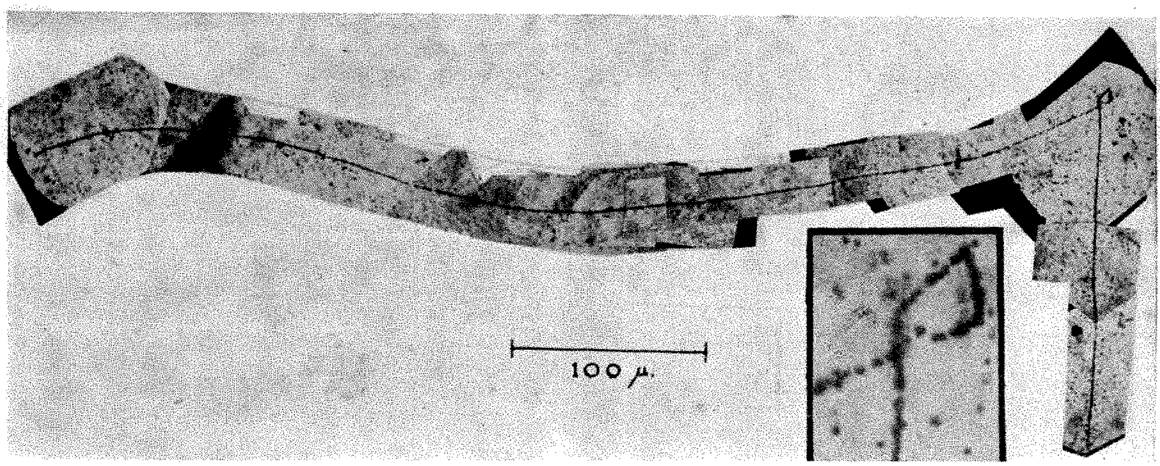
## An Unusual π—μ Decay Track

THE accompanying photograph shows an event observed in an *N.T.*4 plate exposed for several hours at an altitude of some 90,000 ft. in balloon flights made recently at Bangalore. The heavier track enters the emulsion from the air, and gives rise to the lighter track after a path of 535 μ. The lighter track has a range of 571 μ and ends in the emulsion. The event can be identified with confidence as an example of π—μ decay. The grain densities are also consistent with this explanation.



A remarkable feature of the event, however, is the sequence of three large-angle scatterings near the end of the π-track. The μ-track originates at a distance of 2 μ from the third scattering, and passes slightly underneath the π-track, thus forming a closed loop. The inset photograph shows the loop on a larger scale. We have not previously observed the formation of a closed loop by scattering, and the event seems sufficiently curious to be worth recording.

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## Estimation of Heterogeneous Error Variances

WE consider a set of $pq$ observations $x_{ij}$ in a two-way classification, which we may suppose represented by the model

$$x_{ij} = \alpha_i + \beta_j + \varepsilon_{ij} \quad (i = 1, 2, \ldots p\,;\; j = 1, 2, \ldots q),$$

where $\alpha_i$ and $\beta_j$ are constants and the $\varepsilon_{ij}$ are independent normal random errors with zero means and variances $\sigma_j^2$; $\alpha_i$, $\beta_j$ and $\sigma_j^2$ are unknown, and it is desired to estimate $\sigma_j^2$. The problem arises, for example, in investigating the accuracy of a food-tasting panel; $\alpha_i$ depends on the food-specimen tasted, $\beta_j$ is the bias and $\sigma_j^2$ the residual error variance of the $j^{\text{th}}$ panel member.

If $p$ or $q$ is small, the method of maximum likelihood does not give a satisfactory estimate of $\sigma_j^2$. Kendall[1] notes that when $q = 2$ the maximum likelihood estimates of $\sigma_1^2$ and $\sigma_2^2$ are equal, and therefore are not consistent if, in fact, $\sigma_1^2$ and $\sigma_2^2$ are unequal.

It is of interest to consider estimates which are, in the first place, unbiased. One such estimate, valid for $q \geqslant 3$, is

$$s_j^2 = \frac{q}{(p-1)(q-2)} \left\{ \sum_i^p (x_{ij} - x_{i\cdot} - x_{\cdot j} + x_{\cdot\cdot})^2 - \frac{1}{q(q-1)} \sum_i^p \sum_r^q (x_{ir} - x_{i\cdot} - x_{\cdot r} + x_{\cdot\cdot})^2 \right\},$$

where $x_{i\cdot}$ and $x_{\cdot j}$ denote partial means and $x_{\cdot\cdot}$ the overall mean of $x_{ij}$. Another estimate, valid for $q \geqslant 2$, is

$$s_j'^2 = \frac{1}{p-1} \left\{ \sum_i (x_{ij} - x_{\cdot j})^2 - \frac{2}{q(q-1)} \sum_i \sum_{r>s} (x_{ir} - x_{\cdot r})(x_{is} - x_{\cdot s}) \right\}.$$

When $q = 2$ this gives, for $j = 1$, say,

$$s_1'^2 = \frac{1}{p-1} \sum_i (x_{i1} - x_{\cdot 1})(x_{i1} - x_{\cdot 1} - x_{i2} + x_{\cdot 2}),$$

which can be shown to be the only unbiased quadratic-form estimate of $\sigma_1^2$.

The variances of these estimates of $\sigma_j^2$ depend on other unknowns besides $\sigma_j^2$ itself. We find

$$\operatorname{var}(s_j^2) = \frac{2\sigma_j^4}{p-1} + \frac{4}{(p-1)(q-1)^2} \left\{ \sigma_j^2 \sum_{r \neq j} \sigma_r^2 + \frac{1}{(q-2)^2} \sum_{\substack{r>s \\ r,s \neq j}} \sigma_r^2 \sigma_s^2 \right\},$$

which depends on all of $\sigma_1^2, \sigma_2^2, \ldots \sigma_q^2$; and

$$\operatorname{var}(s_j'^2) = \frac{2\sigma_j^4}{p-1} + \frac{p-2}{p(p-1)^2 q^2} \sum_i (\alpha_i - \alpha_\cdot)^2 \left\{ (q-1)^2 \sigma_j^2 + \sum_{r \neq j} \sigma_r^2 \right\} + \frac{4}{(p-1)q^2(q-1)^2} \sum_{r>s} \sigma_r^2 \sigma_s^2,$$

which depends in addition on $\alpha_1, \alpha_2, \ldots \alpha_p$. When $q > 2$ and both estimates are available, sometimes one and sometimes the other has the lower variance, according to the values of the other parameters.

A full discussion is in preparation. The investigation is in connexion with work done on behalf of the Department of Scientific and Industrial Research (Food Investigation).

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## Changes in the Histology of the Honey-bee Ventriculus Associated with the Ingestion of Certain Insecticides

ALTHOUGH the histological changes produced by insecticides have been the object of study by a few investigators[1], the subject has on the whole received little attention. Recently a comparative study of the histology of the honey-bee ventriculus, following the administration, in individual graded doses, of the insecticides, acid lead arsenate, DDT and 'Parathion', has been made. In addition, the median lethal doses for the insecticides were determined, and observations on the behaviour of the poisoned bees and the macroscopical appearance of the mid-guts (ventriculi) were made. For the microscopical studies material was prepared with only slight modifications of standard histological procedures. (The name 'Parathion' is used here for the compound *o,o*-diethyl *o,p*-nitrophenyl thiophosphate.)

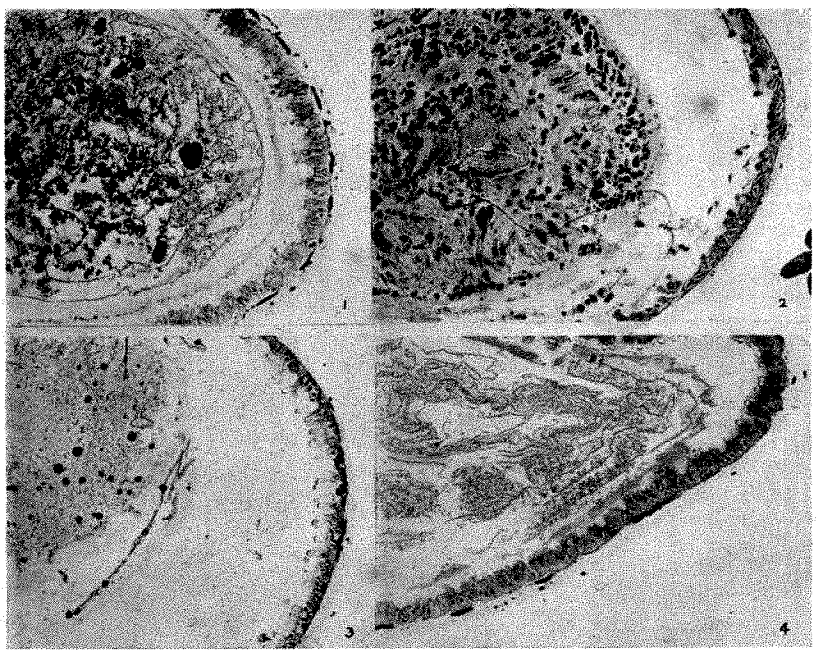
It was found that in some instances there were definite histological abnormalities following the administration of the insecticides. When present, these abnormalities were mostly confined to the middle region of the ventriculus. Photomicrographs of transverse sections through this region of the mid-gut are shown. Fig. 1 is that from a normal bee; Fig. 2 from an arsenic-poisoned bee; Fig. 3 from a DDT-poisoned bee; and Fig. 4 from a 'parathion'-poisoned bee.

Observations on the macroscopic appearance of mid-guts from arsenic-poisoned bees showed that all were lighter in colour than those from normal bees, and that 90 per cent contained a greyish plug-like mass near their posterior end. Microscopically, mid-guts from all arsenic-poisoned bees presented the same appearance: severe vacuolization, desquamation and degeneration of the epithelial cells were characteristic (Fig. 2). Similar effects have been observed in various experiments with other test insects[2,3].

The mid-guts of 50–60 per cent of the DDT-poisoned bees contained a large transparent gas bubble, and a microscopical study of this region (Fig. 3) showed that the epithelial lining was stretched and that increased proliferation, vacuolization and secretion from the epithelial cells were taking place. The epithelial lining of mid-guts containing no gas bubble was not stretched appreciably; but the condition and activity of the epithelial cells were similar. It is suggested that this activity of the epithelial cells is a result of the hyperactivity of the insect, caused by the action of DDT on the nervous system.

Both the macroscopic and the microscopic (Fig. 4) appearance of the mid-guts of 'Parathion'-poisoned bees closely resembled those of normal bees. The hyperactivity and characteristic circus movements of a 'Parathion'-poisoned bee indicated that this insecticide was acting as a nerve poison.

A fuller account of this investigation will be given elsewhere.



I wish to thank Mr. A. J. Musgrave (Ent.) for directing this work, and Mr. G. F. Townsend (Apic.) for advice and encouragement.

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## Functions of Hæmoglobin in *Daphnia*

IN well-aerated waters *Daphnia* is pale, whereas in waters deficient in dissolved oxygen it is pink or red. The depth of colour is proportional to the oxygen deficit[1,2]. The colour is due to hæmoglobin in the blood, and when the animals are transferred from well-aerated to poorly aerated water or *vice versa*, the resulting synthesis or loss of hæmoglobin is very considerable and remarkably rapid. In a week a pale population can become red. The phenomenon is comparable with the increase in the hæmoglobin content of the blood of human beings exposed to the lower oxygen pressure of a high altitude. This increase is functional and it might be expected that the increase in the respiratory pigment of *Daphnia* would also be of value to the animals.

In *Daphnia* not only blood but also the parthenogenetic eggs contain hæmoglobin[3]. The pigment passes from the blood into the ovary[4], and so in oxygen-deficient water the eggs, like the blood, contain extra hæmoglobin. It has been shown that the hæmoglobin in the eggs is of value to *Daphnia* in oxygen-deficient water: it increases the rate of development of the embryos[1]. We have now made extensive studies of the function of the respiratory pigment in the blood, and they are briefly reported below.

The first experiments were made to see whether red *Daphnia* survives longer than pale in oxygen-deficient water. Animals from the same stock were cultured in waters of low and high air content until they became red and pale respectively. Then twenty red individuals were put into a large stoppered bottle completely full of water with a low dissolved oxygen content, just above that at which oxyhæmoglobin can be seen to lose its oxygen in the blood of *Daphnia*[5]. The bottle was sufficiently large for the oxygen content of the water not to be reduced much by the animals during the experiment. Into a similar bottle twenty pale individuals were put. One by one the pale animals died, and when ten of them were dead it was found that all the red individuals were still alive. Several such experiments were made, with the same result, which shows that in poorly aerated water the hæmoglobin synthesized by *Daphnia* helps the animals to survive. Earlier experiments[1] had failed to demonstrate this, the reason probably being that they had not been continued long enough.

The animals in the above experiments received no food. We next tested whether hæmoglobin assists *Daphnia* to feed in water deficient in oxygen. *Daphnia* can clear turbid water by collecting and eating suspended particles; this is done just as much if the particles are inorganic as if they are nutritious algæ. We made use of this faculty and measured the decrease in density of suspensions of graphite caused by *Daphnia*. The changes in optical density of the suspension were measured with a photometer. Preliminary experiments showed that in waters containing less and less dissolved oxygen, progressively less graphite is cleared in unit time. It was next found that hæmoglobin intervenes: at each different low value of dissolved oxygen, red animals can clear more graphite than pale ones. This was confirmed by comparing the clearance by normal red *Daphnia* with that by animals treated with carbon monoxide to inactivate the hæmoglobin as an oxygen carrier: in oxygen-deficient water the normal animals cleared more graphite. Further confirmation was obtained by comparing the clearance, in waters of different oxygen content, of a food alga, *Chlorella*, by red and pale *Daphnia*, and also by animals with oxy- and carboxy-hæmoglobin. The results were the same as with graphite. In aerated water, however, hæmoglobin was found to give no advantage, and indeed in Nature it would have mostly vanished.

It was next found that in poorly aerated water *Daphnia* produces fewer and fewer parthenogenetic eggs in proportion to the oxygen deficit. We therefore made experiments to find out if hæmoglobin assists the egg production. It turned out that at each low value of dissolved oxygen more eggs were laid in the brood pouch by normal red animals than by others with carboxyhæmoglobin. It is known that in *Daphnia* the number of eggs depends upon the amount of food eaten, and the greater number of eggs produced in semi-anaerobic conditions thanks to hæmoglobin may well be due, at least in part, to the better nutrition resulting from the respiratory pigment.

It has thus been shown that the blood hæmoglobin synthesized by *Daphnia* in response to oxygen deficiency in the water has the following functions: it resists asphyxia, and it assists feeding and reproduction. The aid to reproduction is both by producing more eggs and by supplying hæmoglobin to the eggs and so accelerating development.

These results will soon be published in full elsewhere.

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## Supersensitivity of Denervated Organs to Chemical Stimuli

The analysis of phenomena such as the 'pseudomotor reactions' or the 'paradoxical pupillary dilation' has revealed that structures deprived of their normal nerve supply show a supersensitivity to chemical stimuli. In 1939 Cannon formulated the law of denervation: "When in a series of efferent neurones a unit is destroyed, an increased irritability to chemical agents develops in the isolated structure or structures, the effect being maximal in the part directly denervated". In their recent monograph on "The Supersensitivity of Denervated Structures"[1], Cannon and Rosenblueth have discussed various factors which might be responsible for the sensitization of cells after degenerative section of their efferent nerve supply, such as inactivity, suppression of the release of chemical mediators, or removal of some kind of 'trophic' influence of nerves on the cells.

In our experiments we have, instead of excluding nerve impulses by severance of efferent nerves, attempted to make such impulses ineffective on the innervated structures. This can be achieved pharmacologically by treatment with drugs which render the effector cells insensitive to the chemical mediators of nerve impulses. The submaxillary gland of the cat affords a preparation well suited for experiments of this kind. Stimulation of the main secretory nerve of the gland, the chorda tympani, evokes an abundant flow of saliva; after administration of atropine, however, chorda stimulation has no secretory effect. Stimulation of the cervical sympathetic nerve, or intravenous injection of adrenaline, is likewise followed by salivary secretion. This effect is not antagonized by moderate doses of atropine. Some days after section of the chorda tympani, the gland is found to be supersensitive to adrenaline[2]; the threshold dose of adrenaline for the parasympathetically decentralized gland is much smaller than that for the normal gland, and a moderate dose of adrenaline gives a much greater response from the decentralized than from the normal salivary gland.

In a series of cats, atropine was injected subcutaneously twice daily over a period of 7–10 days. As pharmacological and clinical experience suggests that some kind of 'habituation' to atropine may occur, the doses of atropine given were increased successively, the first dose being 0·5 mgm./kgm., the last dose 10–15 mgm./kgm. Some 15–20 hr. after the injection of the biggest dose, the cats were anæsthetized with chloralose. The submaxillary ducts were cannulated, and the sialogogue effect of adrenaline was tested. The atropine-treated glands were invariably found to be supersensitive to adrenaline. The sensitization resembled that brought about by section of the chorda tympani. Thus, in a series of cats in which the chorda of one side had been cut aseptically at the beginning of the atropine treatment, the threshold dose of adrenaline, estimated after atropine pretreatment, was found to be of the same order of magnitude on both sides. A dose of adrenaline which evokes a just perceptible salivary secretion from a normally innervated, untreated gland was found to elicit an almost maximal response after atropine treatment, just as is the case after degenerative section of the chorda. It seems reasonable to assume that the sensitization is brought about in the same way in both instances. The main difference between the two types of sensitization is that section of the chorda abolishes nerve impulses (or at least denervates the submaxillary ganglion), whereas atropine antagonizes the action of the transmitter substance on the effector cells. The atropine experiments, therefore, may shed some light on the mechanism responsible for the sensitization of the gland to chemical agents.

An attempt was made to prevent the sensitization developing after severance of the chorda by daily injections of pilocarpine. Unfortunately, only one cat has so far survived the injection, twice a day, of 1 mgm. of pilocarpine per kgm. during eight days. In this animal the adrenaline sensitivity of the parasympathetically decentralized gland was found to be as low as that of a normally innervated gland.

The experiments described here do not support the theory that the normally innervated gland is subjected to a 'trophic' influence, the disappearance of which is followed by supersensitivity of the gland to chemical agents. Nor can the sensitization occur consequent on a suppression of the liberation of the transmitter substance. Changes in the cells, due to absence of chemical stimuli or to the inability of stimulating substances to attach themselves to certain receptors, may in some way be responsible for the supersensitivity to chemical agents which appears after section of the chorda or pretreatment with atropine.

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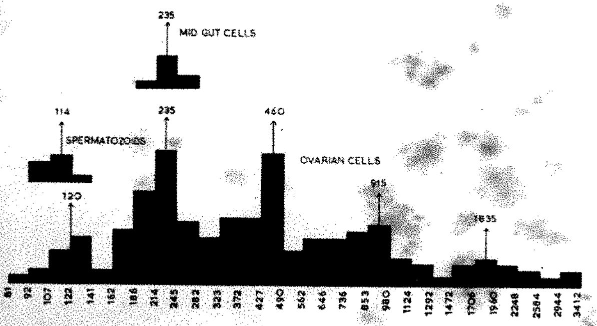
## Deoxyribonucleic Acid Content of Ovarian Cells in *Artemia salina*

In the ovary of *Artemia salina*, some oocytes undergo a peculiar transformation[1]. After the primary growth period, numerous granules giving a positive Feulgen reaction appear in the nucleus, fuse into clumps, and finally give rise to a large homogeneous droplet of strongly Feulgen-positive material. This droplet is expelled into the cytoplasm through a hole in the nuclear membrane. The nucleus remains as a clear vesicle containing nucleoli and ribonucleic



granules but devoid of deoxyribonucleic acid. Finally, the droplet is expelled from the cell and disappears entirely. This process appears to be very different from common pycnosis and caryorhexis. It is, so far as we know, the only case where deoxyribonucleic acid is expelled as a whole into the cytoplasm, while the other components of the nucleus remain apparently unchanged.

Since the constant character of the phenomenon consists in a great increase in the amount of the deoxyribonucleic acid in the nucleus, it was suggested that this peculiar kind of cell degeneration may be the sequel of successive waves of endopolyploidy.

This hypothesis has been tested by determining quantitatively the deoxyribonucleic acid *in situ* by means of histophotometrical measurements (see ref. 2 for details of the apparatus). The material used was fixed in alcohol-formalin (9/1) and sections examined by the Feulgen reaction. Relatively thick sections (10 μ) were used, so even the largest nuclei under investigation were entirely contained in the sections; all the slides were treated together and in the same baths to ensure a uniform Feulgen reaction throughout the whole experiment. Transmittances were measured in the wave-length region 5,200–5,400 A., on areas of the preparation varying between 0·27 $\mu^2$ and 2·41 $\mu^2$. The calculated mean optical density of the object multiplied by its surface gives the amount of deoxyribonucleic acid expressed in arbitrary units; no attempt was made to calculate absolute amounts, and the figures reported here have only relative values.

The results are shown on the accompanying histograms. The relative amounts of deoxyribonucleic acid are plotted logarithmically on the abscissæ, and the relative frequencies of the classes comprised between two successive figures of the horizontal scale are plotted as ordinates.

As reference, the spermatozoa present in the general cavity and the mid-gut cells were measured. As expected, the mean deoxyribonucleic content of the (diploid) mid-gut cells (235 units) was found to be nearly twice the content of the (haploid) spermatozoa (114 units). The contents of the ovarian cells vary between very wide limits. However, the histogram shows clearly the existence of frequency maxima in successive ratios of 1, 2, 4, 8, 16, etc. The arrows on the graph indicate the mean value calculated for each frequency maximum.

The highest frequency maximum, located at 235, corresponds very closely to the theoretical diploid value. The cells belonging to this group are normal oogonia and normal oocytes at different periods of growth, irrespective of their dimensions. The next highest frequency maximum, located at 460, a value double that of the theoretical diploid content, corresponds to cells morphologically identical to the former ones, the density of the nucleus excepted, and the appearance of which is normal. The next maximum, at 915, corresponds to abnormal cells, which begin to degenerate as described previously, and the maximum at 1,835 to cells in which the Feulgen-positive material is collected in large homogeneous drops. At the extreme right of the histogram are cells which are expelling the deoxyribonucleic acid.

The existence of frequency maxima in the successive ratios of 1 and 2 in cells the destiny of which is to degenerate confirms the hypothesis that the origin of cell degeneration in the ovarian cells of *Artemia* is increasing polyploidy by successive reduplication. The first duplication leads to apparently normal cells. Whether these cells can develop further in a normal way is an open question; it may be suggested that the abortive developing eggs showing polycentry which are so common in *Artemia* may be such cells which have undergone maturation and fertilization. The second and third reduplications seem to be always lethal. The shape of the histogram suggests a fourth reduplication, but the expulsion of the deoxyribonucleic acid droplets occurs in many cases before this reduplication is completed.

On the left of the histogram, a frequency maximum at 120, very close to the theoretical haploid value, is clearly visible. All the cells belonging to this group are found in the ventral side of the ovary, in the region of multiplying oogonia. The existence of cells with such a deoxyribonucleic acid content is a puzzling fact. We are inclined to think that they are very young primary oocytes, just after the last oogonial division has taken place. They could be compared to the young spermatocytes of the rat recently studied by Lison and Pasteels[3]. In the rat, the last spermatogonial division follows another division immediately in such a way that no re-synthesis of deoxyribonucleic acid occurs between the two divisions. The content of the very young spermatocytes is therefore half that of the spermatogonia. The oogonia of *Artemia* probably behave similarly; but for the present we have not been able to present direct evidence favouring this view.

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## Polymely in a Frog

The male frog (*Rana temporaria*) described here was found in a batch of frogs from Cornwall (January 1950) which had been killed before the supernumerary limb had been noticed. This supernumerary left fore limb was situated behind the normal fore limb and articulated with the sternum (Figs. 1 and 2). Bateson[1] records frogs with supernumerary limbs and O'Donoghue[2] gives a short summary of the types of supernumerary fore limbs found in frogs up to 1910. Including his own two specimens, O'Donoghue cites thirteen frogs with either one or two supernumerary fore limbs; of these only one (listed, but not described, in the catalogue of the Royal College of Surgeons, 1872) had the supernumerary limb

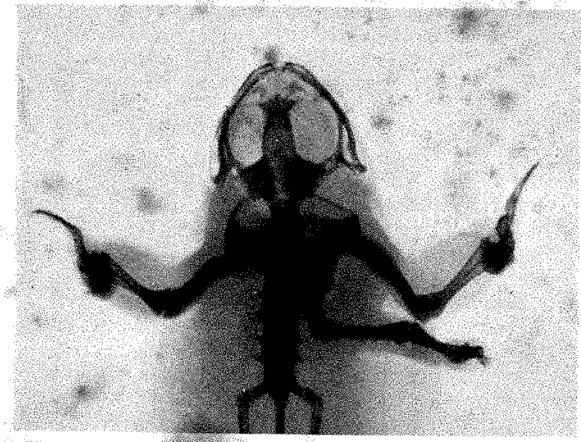

Fig. 1. X-ray showing articulation of supernumerary left fore limb with pectoral girdle

attached to the sternum. Wagner[3] describes a specimen with three extra but imperfect fore limbs (two right and one left) attached to "an extra basal piece overlying the sternum". Cotton[4] records a specimen with an extra right fore limb immovably articulated with an imperfect extra half pectoral girdle. Therefore, so far as I know, the present is the only specimen described with a "sternal glenoid cavity".

The supernumerary limb on this specimen was about four-fifths of the size of a normal limb, and complete as far as the wrist joint; but the metacarpals and phalanges were missing, perhaps as the result of injury. There was good movement in the "glenoid cavity" joint but very little in the elbow joint. In the region of the carpals there was a black sex pad about half the size of the pad on the normal limbs.

The muscles of the sternal region were slightly modified, as fibres from the pectoralis and coracoradialis passed to both the left normal limb and to the supernumerary limb. The other muscles of the limb were not examined in detail; but the general impression was of normal musculature (cf. O'Donoghue and Cotton).

The pectoral girdle was normal except that the anterior end of the mesosternum was bifid, and the posterior end twisted to the left (Figs. 1 and 2), and modified to form a cup-shaped articulating surface ("glenoid cavity") for the head of the humerus. The xiphisternum was apparently missing (probably incorporated into the "glenoid cavity" during develo ment). The humerus and radio-ulna were typic although slightly smaller than those of normal limb also the carpal bones present seemed fairly norm

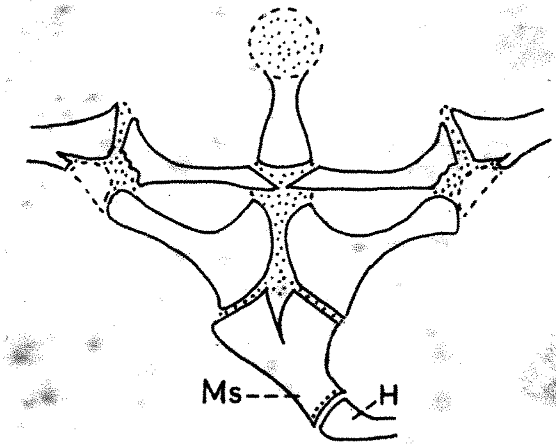

Fig. 2. Explanatory diagram of X-ray: *Ms*, modified mesosternum; *H*, supernumerary humerus

The blood supply to the limb consisted of artery arising from the left subclavian just before entered the normal limb. This artery entered t supernumerary limb a short distance from its pro mal end, and after giving off two small branches the tissue around the "glenoid cavity", it contin down the limb. The veins from the limb joinec form a large vein which entered the subclavian v about halfway along its length.

The nerve supply to the supernumerary limb c sisted of a small nerve (Fig. 3, *A*) arising fror secondary plexus formed by branches of the sec and third spinal nerves; the other branches from plexus supplied the skin and muscles of the body w

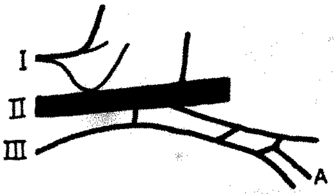

Fig. 3. Brachial plexus: *A*, nerve to supernumerary

The fact that polymely is more common[1] in h limbs than in fore limbs of frogs suggests that production of such limbs is due to injury and t the operculum affords protection to the fore li during a vital stage in development. Although blood and nerve supply to the supernumerary l in this specimen suggest that this limb had a comı origin with the normal left fore limb, it is diffi to see how the articulation with the sternum effected.

A. G. Hamil

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London, S.E.1.
Aug. 9.

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## Suckling Antidiuresis in Rabbits

Little direct evidence exists that the suckling stimulates the release of posterior pit hormone as is postulated in Petersen's[1] theor letdown of milk. Peeters *et al.*[2] reported a antidiuresis in cows which was simulated by venous injection of 4 mU. posterior pituitary This dose had no effect on letdown in th Turner and Cooper[3] described a swelling mammæ in lactating rabbits with intrav injections of 1 mU. posterior pituitary ex Experiments were undertaken to find if suckling rabbits evokes an antidiuretic response which mi be attributable to the neurohypophysis.

Nine crossbred rabbits were studied during thirte lactations. Observations were made between t seventh and thirtieth day of lactation. Does s ated overnight from their litters were given stomach tube 50 c.c./kgm. body weight tepid wa followed 90 min. later by a second dose of 40 c.c./kgm. body weight. The bladder was emptied by manual

ression at 15-min inter-
and the urine volume
sured In most cases the
e flow rose to between 10
20 c c/15 min at the
nd collection and main-
ed this level in control
riments for an hour or
before decreasing The
al course of water diur-
was not found to be
icantly affected by gentle
ling, presence of stran-
laboratory noise, con-
ent with the litter with-
ursing, or even coitus
fifty-four experiments,
ng was allowed during
ight of a water diuresis
ty-eight cases the urine
as diminished by 30–90
nt Maximum oliguria
rved most frequently
hour after suckling,
of the urine flow
g by $\frac{3}{4}$–1 hr During
diuresis, the chloride
ration of the urine
, estimated by the
rn method, increased
much as four times
suckling level In five experiments the
urinary chloride excretion also increased
gnitude of the responses bore no obvious
to the amount of milk withdrawn, the
of suckling or the size of the litter
tidiuretic responses following suckling were
those following intravenous injections of
es of 'Pituitrin' (Parke Davis Co ) Assays
nimals indicated an effect equivalent to
U posterior pituitary extract
xperiments support the view that suckling
bit stimulates the release of neurohypo-
rmone The relation, if any, between
tidiuresis and letdown remains undeterm-
rther experiments are in progress to
he role of the neurohypophysis in both

express my thanks to Dr G W Harris
ractical help and advice during the course

B A Cross

l Laboratory,
bridge
e 30

tersen, W E , *J Dairy Sci* , 24, 211 (1941)
ns, Boukaert and Oyaert, *Arch int Pharmacodyn* ,
), and private communication
and Cooper, W D , *Endocrin* , 29, 320 (1941)

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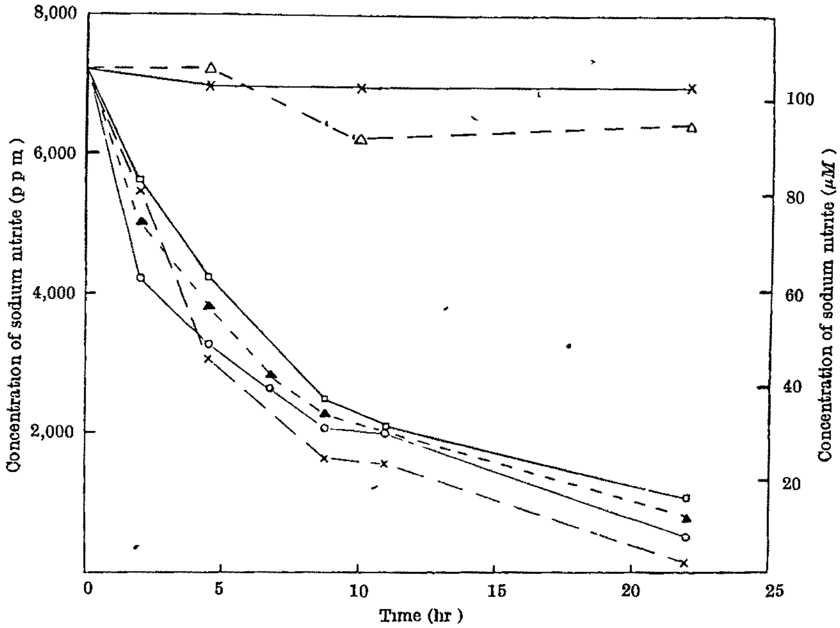
## vation of Fish by the use of Nitrite Ice

recently published accounts of work on
rites in the preservation of fish$^{1-3}$, the
experiments carried out here in 1941,
ully reported elsewhere, are of interest
iments, which formed part of a war-
e, were designed primarily to explore
of improving the keeping quality of
of ice in which various preservatives,
such as hydrogen peroxide, formaldehyde, sodium nitrite, etc , had been incorporated

Briefly, it was shown that by using concentrations of 0 1 per cent and 0 15 per cent sodium nitrite in the ice, the period of 'freshness' of the fish, as judged organoleptically, could be prolonged for an extra three to four or seven to eight days respectively, as compared with controls in ordinary ice The chemical data showed that the production of trimethylamine, the concentration of which was used as an objective index for quality, was correspondingly suppressed Where ice containing 0 1 per cent sodium nitrite was continuously renewed to replace wastage through melting, the nitrite concentration in the flesh of the iced fish rose and reached 400 p p m about the tenth day, after which it rapidly declined, reaching zero about the twenty-third day With 0 15 per cent sodium nitrite in the ice, the decline from a peak value of 500 p p m began after the fifteenth day, but some nitrite remained even after the twenty-third day It seemed very probable that bacterial reduction was mainly responsible for the fall in nitrite concentration, and indeed it was comparatively easy to isolate in pure culture many strains of bacteria which were shown to reduce sodium nitrite It was found, in agreement with the Canadian workers, that these reducers belonged mainly to the *Pseudomonas* group, although some *Achromobacter* strains were also involved



Elimination of sodium nitrite by *Achromobacter* sp ×——×, heated bacterial suspension, △— —△, control (no bacterial suspension), □——□, bacterial suspension, no donator added
×——×, ,, ,, + sodium lactate
▲——▲, ,, ,, + ,, succinate
○——○, ,, ,, + glucose

Although *Pseudomonas* and *Achromobacter* strains reducing sodium nitrite had already been described$^{4-7}$, the reduction mechanism was—and still is—ill-defined For this reason one of the micro-organisms, probably an *Achromobacter* species, which vigorously reduced sodium nitrite in fluid medium with foam formation, was isolated at the time of these experiments for a further study of the enzyme system involved The work, however, had soon to be abandoned in the face of more urgent problems, and shortly afterwards the collection of stock cultures, including the sodium nitrite reducers, was lost So far it has not been possible to return to the problem, but the preliminary results then obtained showed that (1) the organism at $pH$ 7 0 actively reduced sodium nitrite to free nitrogen, only traces of ammonia being formed at the same time, as no attempt was made to set up a nitrogen balance, it was impossible to say whether all the sodium nitrite was reduced to free nitrogen or had been partly assimilated or converted into other nitrogenous compounds such as hydroxylamine, amino-acids, etc, (2) the reduction, with well-washed cells, appeared to be practically unaffected by the addition of glucose, succinate and lactate as hydrogen donators, (3) the enzyme system appeared to be sensitive both to toluene and potassium cyanide, (4) the organism reduced sodium nitrate to nitrite, but at a much lower rate than that of the reduction of sodium nitrite to nitrogen

The work described in this communication was carried out as part of the programme of the Food Investigation Organisation of the Department of Scientific and Industrial Research

J M SHEWAN

Torry Research Station,
Aberdeen
May 31

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## Availability of the Magnesium of Grass to the Ruminant

IN a previous communication under the above title[1], it was shown that the greater part of the magnesium of grass is liberated during the processes of ruminal and abomasal digestion The ability of the animal to absorb this magnesium has been further studied

It was unfortunately not found possible to carry out accurate determinations of magnesium balances, and experiments were confined to the determination of the percentage utilization of the dietary magnesium In view of Nicolaysen's results[2], which indicate that the magnesium of fæces is unabsorbed food magnesium with a small amount derived from intestinal secretions, it was considered that, despite the limitations of the method, some information of value might be acquired

At the time this work was commenced, the only suitable small laboratory animal available was the guinea pig It has been shown that ruminal organisms play only a small part in the liberation of magnesium of plant materials[1], and it was assumed that results obtained using a non-ruminant herbivore such as the guinea pig would not differ widely from those obtained with the ruminant This has since been shown to be the case by applying a lignin-ratio technique and using cattle

Grass samples were collected during the dry season of 1948–49 (October–February) and during the wet season of 1949 (June–August) No attempt was made to separate species of grasses, and all samples were cut at random from pastures normally grazed by cattle, with the exception of one sample of wet-season grass which came from an area on which cattle had not been pastured This sample, and the dry-season samples, consisted largely of spear gra (*Imperata cylindrica*) A list of the other princip grasses found at this Laboratory has been publish elsewhere[3] All the hay had been made from gr cut in August and September 1948

A stock of grass sufficient for the whole expe mental period was cut at one time and stored un conditions designed to keep it as fresh and moist possible Random samples were taken from stock for the estimation of magnesium, calc phosphorus, lignin and crude fibre At first an atte was made to estimate lignin by a method base the separation technique described by Bondi Meyer[4], but inconsistent results were obtained the method of Ellis, Matrone and Maynard[5] therefore used In the latest series the metho Armitage, Ashworth and Ferguson[6] has been ployed

It was found that, in this series of experim 65–86 per cent of the magnesium of fresh gr retained by the guinea pig and 63–74 per ce cattle Rather less (35–58 per cent) of the nesium of hay is retained by the guinea pig

The amount of magnesium retained is appa not dependent upon the magnesium conten calcium–phosphorus ratio or the crude fibre c of the food

I am indebted to Mr W G Beaton, direc veterinary services, Nigeria, for permission to this communication

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Vom, Northern Nigeria
May 25

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## Effect of Temperature on the Consolidation of Soils

IN civil engineering practice it is s necessary to estimate the probable rate of s of structures founded on clay and other co soils The settlement arises from a proc known as consolidation, in which the app a load to the surface of the soil causes w expelled from its pores *A priori*, it wo pected that the rate of consolidation of the be a function of the kinematic viscosity o and since the latter depends upon the te it follows that the rate of consolidation be a function of temperature

In order to check this hypothesis an e study has been made of the effect of tem the rate of consolidation of saturated London clay Samples of soil 3 in in d 1 in thick restrained laterally were between two porous disks, and the comp various periods of time up to twenty-fo noted The tests were made at a numbe tures between 15° C and 45° C The resu that, within the limits of experiment coefficient of consolidation (a functio of the process) was inversely propor kinematic viscosity of water

Since the temperature of the subsoil at depths normally encountered in civil engineering work is of the order of 10° C , it is thus necessary to make a correction for temperature when making estimates of settlement from the results of consolidation tests carried out on samples of soil at normal laboratory temperatures (say, 20° C ) Failure to make this correction can result in appreciable errors in the estimation of settlements , for example, if the laboratory tests are carried out at 20° C and the average temperature at foundation-level is 10° C , the estimated settlement at any given time would be about 30 per cent too great It is suggested that the neglect of this factor may be partly responsible for some of the considerable discrepancies noted in the past between calculated and measured settlements of structures founded on compressible soil

The work described above was carried out at the Road Research Laboratory of the Department of Scientific and Industrial Research as part of the programme of the Road Research Board This note is published by permission of the Director of Road Research

W A LEWIS

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May 26

## Ultrasonic Soldering of Aluminium

FOR some years it has been known that it is possible to tin aluminium and its alloys by subjecting their surface to the action of intense ultrasonic vibration at the same time as molten solder is applied[1-3] , but the mechanism for this effect does not seem to have been studied We have now established that the process is one of removing the oxide skin by cavitation erosion

A specimen of aluminium was immersed in a bath of molten solder, to which were communicated vibrations at a frequency of 18 kc /s , set up by applying 50 W to the driver coil of a small magnetostrictor The exact amplitude of oscillation in the bath could not easily be determined, but was adequate to tin an aluminium surface immediately at atmospheric pressure When, however, the experiment was repeated with an ambient pressure of 4 atmospheres, tinning was completely prevented Since the increased pressure can have had only a negligible effect on any factor other than cavitation, this seems convincing evidence of the essential part played by the latter

Aluminium is known to have a low resistance to cavitation erosion, even in water[4], so it is not surprising that collapsing voids in molten solder will be able to disrupt the surface, exposing the aluminium underneath for alloying with the metal which is impinging violently against it in the very action of cavitation We can expect, moreover, that the usefulness of the ultrasonic technique for tinning different 'difficult' metals will be related to their susceptibility to cavitation erosion In the limited studies that have so far been made, this has been found to be true

We have found that ultrasonic cavitation must be expected to be more severe at lower frequencies[5], so we should expect that ultrasonic tinning would also be more effective in this region Most experiments that have been reported have been done at relatively low frequencies, although it has been implied that vibration at 1,750 kc /s can facilitate soldering[6] We have used a 1,000-kc /s crystal to which 3 kV (root mean square) was applied, and have verified that it was not possible to tin aluminium in a pool of molten Wood's metal resting on it, although such tinning occurred quite readily in the low-frequency bath, where the ultrasonic intensity was appreciably lower

Thanks are due to the directors of the Mullard Radio Valve Co , Ltd , for permission to publish this note, and to Dr C F Bareford, manager of the Electronic Research Laboratory, for his help in the work described

B E NOLTINGK
E A NEPPIRAS

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Nr Redhill, Surrey.
June 8

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[6] Sivian, L J , U S Patent 2,426,650

## The Discovery of Magnesium

IN a recent little book entitled "The Story of Magnesium", issued by the American Society of Metals in 1949, the author, W H Gross, states (p 17) "The discovery of magnesium is generally attributed to Sir Humphrey [*sic*] Davy in 1808 He did not actually obtain magnesium in metallic form, but merely established the fact that magnesium oxide was the oxide of a new metal Magnesium was first isolated in 1828 by the French scientist Bussy "

Such a statement is entirely misleading, as a study of the paper read before the Royal Society by Davy on June 30, 1808, and published in the *Phil Trans* , 98, 333 (1808), renders abundantly clear

After describing his now well-known method of obtaining an amalgam using a mercury cathode, Davy states that he heated it in a glass tube from which all air had been expelled "I found immediately that the mercury rose pure by distillation from the amalgam and it was very easy to separate a part of it , but to obtain a complete decomposition was very difficult For this nearly a red heat was required, and at a red heat the bases of the earths instantly acted upon the glass and became oxygenated The metal from magnesia seemed to act upon the glass even before the whole of the quicksilver was distilled from it In an experiment in which I stopped the process before the mercury was entirely driven off it appeared as a solid having the same whiteness and lustre as the other metals of the earths It . quickly changed in air, becoming covered with a white crust and falling into a fine powder which proved to be magnesia" ("Alembic Club Reprints", No 6 , 1894)

Although Davy may not have succeeded in obtaining magnesium entirely free from mercury, there can be no doubt that in some of his experiments he obtained an almost pure product Who would expect high chemical purity at the first attempt ? Davy did far more than merely establish the fact that magnesia was the oxide of a new metal

There was, of course, no 'e' in Davy's Christian name

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Birmingham 13

# FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

## Monday, October 9

Chemical Society, Southampton Section (joint meeting with the Mid-Southern Counties Section of the Royal Institute of Chemistry and the Portsmouth and District Chemical Society, at the Municipal College, Portsmouth), at 7 p m —Prof H J Emeléus, F R S "The New Elements"

## Tuesday, October 10

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Prof J B S Haldane, F R S "Human Biology as an Academic Topic" *

Physical Society, Acoustics Group (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S W 7), at 5 p m —Mr E A G Shaw "The Rectangular Acoustic Wave-Guide—a Study of Plane and Higher Order Mode Waves and their use in Acoustic Impedance Measurements of Porous Surfaces at Normal and Oblique Incidence"

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W 8), at 5 p m —Scientific Papers

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 30 p m —Sir Henry Dale, O M , F R S "Scientific Method in Medical Research" *

(Further Lectures on October 12, 17, 19, 24, 26, 31, November 2, 7, 9, 21, 23, 28, 30, December 5, 7, 12, 14, 19 and 21 )

University of London (in the Meyerstein Lecture Theatre, Westminster Medical School, Horseferry Road, London, S W 1), at 5 30 p m —Prof D Keilin, F R S "Nature and Properties of certain Metalloprotein Enzymes" *

Manchester Geographical Society (in the Geographical Hall 16 St Mary's Parsonage, Manchester), at 6 30 p m —Sir Harry Lindsay "The Scope and Pattern of Geography"

Society for Visiting Scientists (at 5 Old Burlington Street, London, W 1), at 7 30 p m —Discussion on "Virus Research Present and Future" (Speakers Dr C H Andrewes, F R S , Mr F C Bawden, F R S , Mr N W Pirie, F R S )

Royal Society of Medicine, Psychiatry Section (at 1 Wimpole Street, London, W 1), at 8 p m —Dr E O Lewis "Intelligence in relation to Modern Social Trends" (Presidential Address)

## Wednesday, October 11

Society of Chemical Industry, Microbiological Panel of the Food Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W 1), at 3 p m —Symposium on "Air Disinfection and Sterilisation"

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6 30 p m —Mr E J Heeley "A Metallurgist in the Chemical Industry" (Presidential Address)

## Thursday, October 12

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Prof J Z Young, F R S "Man as a Subject for Scientific Study" *

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S E 5), at 3 p m —Dr B Katz "The Nature of the Nerve Impulse" *

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Mr E A C L E Schelpe "The Vegetation of Mount Kenya" (illustrated by a Kodachrome cine film)

Wool Education Society (in the British Council Film Theatre, 6 Hanover Street, London, W 1), at 6 30 p m —Prof J B Speakman "Careers in Wool" (Inaugural Lecture)

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Scientific Papers

## Friday, October 13

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Prof Joel Stebbins "The Electrical Photometry of Stars and Nebulæ" (George Darwin Lecture)

Chemical Society, South Wales Section (joint meeting with the Royal Institute of Chemistry and University College Chemical Society, at University College, Swansea), at 5 30 p m —Prof F Challenger "Some Aspects of the Chemistry of Sulphur Compounds occurring in Nature"

Chemical Society, North Wales Section (joint meeting with the University College of North Wales Chemical Society, in the Department of Chemistry, University College of North Wales, Bangor), at 5 45 p m —Prof T S Wheeler "Studies in the Synthesis of Flavones"

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St Helens), at 6 p m —Prof W E S Turner, F R S "The Chemical Durability of Glass"

## Saturday, October 14

Physical Society, Colour Group (at University College, Gower Street, London, W C 1), at 11 a m and 2 30 p m —Symposium on "The Technique of Subjective Judgments"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Secretary to the British Pharmacopoeia Commission—The Chairman, British Pharmacopoeia Commission, 44 Hallam Street, London, W 1 (October 14)

Demonstrator in Physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W C 2 (October 16)

Research Assistant (graduate) in the field of vacuum spectroscopy (a good honours degree in physics and some experience in high vacuum work are required)—Prof R W Ditchburn, The University, Reading (October 16)

Chemist to carry out investigations on the problem of spray retention on foliage—The Secretary, Research Station, Long Ashton, Bristol (October 21)

Assistant Lecturers (3) in the Department of Physiology, for posts in Physiology, Biochemistry and Biophysics—The Registrar, University College, Cathays Park, Cardiff (October 28)

Lecturer in Moral and Political Philosophy in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (Sydney, October 31)

Meteorological Officers (6) in the Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 31)

Senior Lecturer in Chemical Engineering at the New South Wales University of Technology—The Agent General for New South Wales, 56 Strand, London, W C 2 (October 31)

Technical Assistant (male) to the head of establishment at the Air Ministry Survey Production Centre at present located at Teddington, Middlesex—The Secretary, Civil Service Commission, Scientific Branch, London, W 1, quoting No 3310 (November 9)

Lecturer or Assistant Lecturer in the Fluid Motion Laboratory —The Registrar, The University, Manchester 13 (November 11)

Chair of Mathematics in the University College, Dundee—The Secretary, The University, St Andrews (November 15)

Lecturer in the Department of Geography at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 15)

Assistant Lecturer in Geography—The Registrar, The University, Nottingham

Assistant Lecturer (Grade III—Non-Medical) or Lecturer (Grade II—Medical) in Physiology—The Secretary, The University, Birmingham 3

Assistant to undertake analytical biochemistry work in the Research Unit for Juvenile Rheumatism—The Director, Special Unit for Juvenile Rheumatism, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead, Berks

British Rubber Producers' Research Fellowship, tenable in the Department of Mechanical Engineering—The Registrar, The University, Nottingham

Chemist with the Colonial Insecticides Research Unit now operating in Tanganyika—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London S W 1

Demonstrator (graduate with experience in Chemical Analysis) in the Environmental Archæology Department—The Secretary, Institute of Archæology, Inner Circle, Regent's Park, London, N W 1

Demonstrator in Pharmacy—The Registrar, The University, Nottingham

Director of the Royal Horticultural Society's Gardens, Wisley, Surrey—The Secretary, The Royal Horticultural Society, Vincent Square, London, S W 1, marking envelope "Confidential"

Entomologist for the Medical Department, Gold Coast—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting Ref No 27215/159

Geophysicist and a Geologist for service in the Geological Survey of the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S W 1, marking envelope "Geophysicist" or "Deputy Government Geologist", as appropriate

Lecturer in Chemistry—The Principal, Royal Technical College, Salford 5

Lecturers or Demonstrators (part-time) in Botany or Zoology in the Intermediate and Final B Sc Courses—The Clerk, Northern Polytechnic, Holloway, London, N 7

Lecturer in Mechanical Engineering, particularly Mechanics, for the Department of Civil and Mechanical Engineering—The Secretary, Royal Technical College, Glasgow

Principal and Lecturer in Agriculture and Biology at the College of Agriculture in Mauritius—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting Ref No 27059/257

Research Fellows in (*a*) Climatology (open especially to graduates in botany and agronomy), and (*b*) Physiology (open to graduates in geology, soils and geography)—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada

Senior Assistant (Scientific) in the Department of Nutrition, to be engaged mainly in physico-chemical methods of estimating vitamins and other factors—The Secretary, National Institute for Research in Dairying, Shinfield, Berks

Senior Hospital Physicist at the Radiotherapy Centre, Queen Elizabeth Hospital—The Secretary, United Birmingham Hospitals, The Queen Elizabeth Hospital, Birmingham 15

Senior Lecturer (Senior Assistant) in Metallurgy—The Principal, Sir John Cass College, Jewry Street, Aldgate, London, E C 3

Technical Officer (Mapping) required by the East Africa High Commission for the Desert Locust Survey Headquarters at Nairobi —The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M/N/26642/3E

# ATURE

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## NATIONAL
## THEIR

THE main theme of the re
British Association at Birming
in the service of man, but in develop
in his presidential address Sir Haro
emphasized the need for balance and for con
in the development and utilization of world res
The need for an ecological approach to the prob
of to-day was noted in one or two of the sectional addresses and in such discussions as those on forestry in water-catchment areas, the factors limiting food production in Britain and the rehabilitation of derelict areas, as well as in the scientific survey, "Birmingham in its Regional Setting", prepared for the meeting. The address which Sir Patrick Duff gave before the Conference of Delegates of Corresponding Societies on September 4 was thus in harmony with the main theme of the meeting Moreover, the early establishment of nature reserves in Britain and the effective working of the Nature Conservancy are matters of immediate concern to several sections of the Association

Only a small audience, however, listened to this general account of the projected work of the National Parks Commission from its chairman, and which admirably supplemented the pamphlet on "National Parks and Access to the Countryside"* already issued by the Ministry of Town and Country Planning and the Central Office of Information Apart from its excellent historical survey, that pamphlet presents a scrupulously fair account of the Act and of the essential criticism that has been advanced of it Sir Patrick naturally did not enter on controversial issues, but he was equally fair and made it plain that the success of the national parks experiment in Britain, and indeed also of the nature reserves (for the latter the Commission has no responsibility), depends on enlisting sufficient help, interest and enthusiasm from the scientific community Intelligent and public-spirited people are needed to spread awareness of what areas of unspoiled countryside mean to the nation, and to foster the idea of considerate behaviour and of mutual respect between towns-folk and country-folk

Sir Patrick's address to the Conference was well designed to assist that task of education and to remove some of the popular misconceptions He pointed out, for example, that the proposed parks are only 'national' in the sense that the whole country has a deep public interest in keeping relatively unspoilt the country that comprises the parks, and that for certain purposes national funds can be made available in respect of them The real effect of designating any area as a national park is, as pointed out in the annual report of the Council for the Preservation of Rural England†, first to bring a new planning machinery into being, and to apply higher planning standards in controlling and directing

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* National Parks and Access to the Countryside Pp 16 + 7 plates (London H M Stationery Office, 1950) 6*d* net

† Council for the Preservation of Rural England Annual Report, 1949–50 Pp 56 (4 Hobart Place, London, S W 1)

dly, to give the planning
so 'managing' the park as
ly for the accommodation
s visitors The normal life of
agricultural and other activities of
s would continue as before, and, as
lic access, the designation of a national
ld in itself effect no change at all
atrick confirmed that it is hoped to designate
Lake District, Snowdonia and the Peak District as national parks by the end of 1950, and he quoted with approval the principle laid down by the late John Dower in his report in May 1945 that such designation should mean that in such areas, of the possible purposes for which the land might be used and developed, two must stand supreme the characteristic beauty of the landscape shall be preserved, and the visiting public shall have ample access and facilities within it for open-air recreation and for enjoyment of its beauty Other and utilitarian purposes are not excluded, but within such areas they must be controlled and harmonized with these dominant purposes The administration would not, Sir Patrick admitted, lie with the Commission, but with the local planning authority, and he recognized that the entire success of this great experiment depends on the co-operation of the local authorities with the Commission and with each other, and on the enthusiasm and competence of the local administration

The recent annual report of the Council for the Preservation of Rural England, from which Sir Patrick quoted, provides for the publicity which his address by itself is unlikely to receive Moreover, its observations indicate the importance of certain questions which Sir Patrick himself did not raise, but which bear as closely on the success of the national parks and the nature reserves as any that he mentioned It is clear that the Council is as alive as the National Park Commission to the importance of seeing that the increased facilities for public enjoyment of the countryside which the Act provides should not result in damage to property, interference with agriculture or inconvenience to people who live and work there Its greatest concern, however, is with the adequacy of the administrative arrangements for both the national parks and the Nature Conservancy for fulfilling their declared purposes in the face of the threats which are offered by government departments and public undertakings

Like the report from the corresponding Council for Rural Wales, the report is emphatic that the demands of the Service departments represent the most serious of these threats There is still no sign of any attempt to co-ordinate such demands, and both reports comment strongly on the unexplained and well-nigh incredible delays which occur in announcing the Government's decisions on cases which have been the subject of public inquiries Since the last annual report of the English Council was published nearly a hundred and fifty requirements, frequently involving encroachment upon agricultural land, have come under consideration by the Council's Executive Committee, and details of a few of these are included
in the report Sometimes objection has n
necessary, and in general the Service depar
appear to be less blameworthy than som
regard to agricultural land But
public inquiries were held during
manifest misgivings of the Council
value and purpose of such public in
in connexion with the Services' land
should be heeded by the Governmen

No responsible section of opinion
necessity for setting aside land for
purposes, but equally no responsible p
recognize that there is a limit to the am
which can be allocated for that purpo
meal formulation of the Services' land
the failure to co-ordinate them and to
of that limit, and the manner in wh
inquiries are conducted, dissipate much
create an atmosphere of distrust and
which the co-operation required to
parks or nature reserves effective will b
difficult to secure The report itself dir
to the way in which slight extensions hav
been made to the boundaries of Services
requirements have been fully investigate
approved, and these have led to appreh
does much to frustrate the policy of 'good
ness' which the Services often profess

Although the matter of Service land
widest disquiet, there are many other
which, as this report indicates, constant
required The County Councils' Associa
sixtieth annual report commented upon t
co-operation of some government depart
their failure to consult with the loca
authorities in the erection of buildings and
ment generally on government property
for the Preservation of Rural England
ticularly to the development attending
Research Station at Capenhurst in the
in this connexion comments that while
desire to put obstacles in the way of urge
ments in the national interest, planning
cannot carry out their statutory duty
schemes, when they are not consulted abo
of development, their protests dismissed
opinion disregarded The difficulties of
tion already indicated are increase
remissness

Fundamentally the trouble here, as i
of Services' lands, is one of depart
allowed to judge their own cause, and
for the Preservation of Rural England
of its value from its ability to take
national point of view Elsewhere in i
example, with reference to the indiscrim
of colliery waste, overburden from ston
clay workings and tunnel excavation
household refuse, which has been a matt
particularly in Lancashire, Shropshire
District, the Council expresses the v
National Coal Board should not be gi
leged position of a statutory undertaker regardin
right to claim compensation in respect of the unde

he accompanying figure from my paper[8] shows alues at the boundary of the hole Cauchy strains f order 65 per cent occur at θ = 90°, while at θ = 0° straining-rotation is of order 30° These rtainly finite values Other cases of 'plane and 'plane strain' that have been solved are severely deformed quadrantal cantilever[8] and a linder generated from a flat plate[9] Solutions of e three-dimensional equations are required isson's is the governing equation and indicates mplete analogy with the electrical equations Stress tential is analogous to electric potential, and ress is analogous to gradient of electric force[7]

K H SWAINGER

perial College of Science and Technology,
S W 7

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[1] Swainger, K H, *Phil Mag*, 38, 422 (1947)

[2] Proc Seventh Intern Congr App Mech, London, Sept 1948

[3] Communicated to *Quart J Mech and App Math* (June 1950)

[4] Communicated to *Quart J Mech and App Math* (July 1950)

ove, A E H, "Mathematical Theory of Elasticity", 49 (Cambridge Univ Press, 1934)

eatherburn, C E, "Advanced Vector Analysis" (G Bell and Sons, 1937)

wainger, K H, communicated to *J Franklin Inst* (April 1950)

*pp Sci Research, Holland* (in the press)

*App Mech*, 15, 45 (1948)

## nomalous Results of Moth-Proofing Tests

THE findings reported by Lamb under this title[1] are usual but may be explained along the following es

When either of the two moth-proofing agents was plied from acid solution at 60° C, the fabric haved normally, it had acquired a good proof ich gradually diminished in efficiency on repeated shings, because some of the moth-proofing agent as gradually washed out

When the proofing agent was applied to the fabric ng with a dyestuff from a neutral bath at 100 C, d the bath was acidified only just before the moval of the fabric from it, the quality of the proof s unsatisfactory The reason is probably that the ofing agents were applied incorrectly, they are n supplied as sodium salts[2] which have little or affinity for the wool, and they must be converted o the free sulphonic acids in order to gain subtivity In the experiment which Lamb describes, acidification was made only just before the fabric removed from the bath, the proofing agents, in the form of free sulphonic acids, would nediately attach themselves to the wool, but gularly, because before they had time to penetrate fabric thoroughly, the fabric was removed Acid st s behave similarly, they may be completely lied o the wool in a few minutes, but are irregu- y distributed, and dyeing is ordinarily continued perhaps another half-hour for levelling to take ce, for the dyestuff to distribute itself uniformly th-proofing agents of the type described by Lamb in effect colourless dyestuffs, they were applied gularly and had no time to level up The poor lity of the proof was due to the irregularity of lication of the proofing agent

hen the fabric which had the unsatisfactory proof washed several times with a commercial soap der, the quality of the proof improved a little reason may well be that during washing some ortunity for redistribution over the fabric would afforded to the proofing agent, still present on the l as the free sulphonic acid (good commercial soap powders are neutral or nearly so) The more uniform distribution of the moth-proofing agent would improve the quality of the proof, there would be some loss of proofing agent during washing, but whereas this loss would have a small adverse effect on the quality of the proof, its effect would be more than counterbalanced by the improvement in the proof due to the more uniform distribution of the proofing agent

R W MONCRIEFF

3 Church Square,
Harrogate

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[1] Lamb, K P, *Nature*, 166, 37 (1950)

[2] Moncrieff, R W, Mothproofing", 68 (London, 1950)

## Ancient Bored Stones

WITH reference to Mr A J H Goodwin's recent letter under the head of "South African Stone Age Terminology"[1], may I point out that the type station of the Magosian is in Uganda, not in Kenya[2], and in doing so remedy an omission

I found the Magosi site in 1925 and surveyed and dug it in November 1926, with the aid of funds supplied by the Percy Sladen Trustees All the many artefacts recovered were sent to Mr M C Burkitt for study and description—or so I thought, but I was away when they were dispatched, and long afterwards I discovered that one specimen, the largest and the only one of its kind, had been omitted from the parcel, and therefore from the description of the culture It was a rather poor but indubitable example of a bored stone Unless my memory fails me, it came from the 2–4 ft level It was at that time, so far as I know, the oldest on record

In this connexion it is interesting to note that in December 1949 I was shown, in the National Museum, Bulawayo, a bored stone recently found in association with a Magosian culture in Southern Rhodesia, and was told of another

Here, perhaps, is the place to recall that nearly twenty years ago I published a short account of a bored stone I had recovered, sixteen months previously, from well-bedded sands and areno-argillaceous beds at a depth of 16 ft below a rubble deposit (itself covered by about 4 ft of undisturbed red earth) rich in East African Acheulean implements[3] This was apparently the *M*-horizon[4], and the bored stone was *in situ* A considerable problem was thus raised

Three years ago, I seized the chance to re-investigate the matter, and further excavation into the supposed *M*-horizon, near the shaft that had yielded the bored-stone, produced not only cleavers, hand axes and other Acheulean-type implements, but also two pieces of flat, artificially ground stone Clearly the originally supposed *M*-horizon is spurious and re-made, and is bored-stone or post-bored-stone in age

The significance of the deposits yielding this artefact, and of the pseudo-Acheulean rubble layer above them, will be discussed elsewhere

E J WAYLAND

Geological Survey,
Lobatsi,
Bechuanaland Protectorate
July 19

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[1] *Nature*, 165, 1026 (1950)

[2] Wayland, E J, and Burkitt, M C, *J Roy Anthrop Inst*, 62, 369 (1932)

[3] *Nature*, 128, 103 (1931), and *Uganda J*, 1, No 1, 69 (1934)

[4] Wayland, E J, Bull 2, Geol Surv Uganda, 69 (1935)

## FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

### Monday, October 16

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Dr Philipp Frank "The Positivistic, the Metaphysical and the Sociological Interpretations of Science"

### Tuesday, October 17

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1 p m —Mr N F Kristy "The Vocational Guidance Programme of the U S Veterans Administration"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Mr M Abercrombie "Unresting Cells" *

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S W 7), at 2 30 p m —Dr K L Blaxter "Iodinated Proteins and Thyroxine in Animal Husbandry" *

University of London (in the Wright-Fleming Institute Lecture Theatre, St Mary's Hospital Medical School, Paddington, London, W 2), at 5 p m —Prof U S von Euler "Hormones of the Sympathetic Nervous System and the Adrenal Medulla" *

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Prof T H Davey "Colonial Medical Policy in relation to Population Growth" *

Royal Society of Medicine, Pathology Section (at 1 Wimpole Street, London, W 1), at 8 p m —Prof Wilson Smith "The Evolutionary Approach to Problems of Infection" (Presidential Address)

### Wednesday, October 18

Royal Institute of Chemistry (at the Cora Hotel, Upper Woburn Place, London, W C 1), at 3 30 p m —Symposium on "The Chemist Outside the Laboratory"

Royal Meteorological Society (joint meeting with the Scientific Film Association, at 49 Cromwell Road, London, S W 7), at 5 p m — Discussion on "The Use of Films in Meteorology"

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W 1), at 5 p m —Prof A Haddow "Recent Progress in the Study of Carcinogenesis" (Presidential Address)

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 5 30 p m —Prof R J Sarjant 'Ignipotence" (Melchett Lecture) *

### Thursday, October 19

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S W 7), at 5 p m —Mr D W Fry "Work on the Linear Electron Accelerator", Dr G P S Occhialini "Physical Problems in Cosmic Ray Research"

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m — Mr W L G Muir "Scientific Method in Mining", Prof David Williams "Gossanized Breccia-Ores, Jarosites and Jaspers at Rio Tinto, Spain"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof L G Romell "Experimental Forest Ecology" * (Further Lecture on October 20 )

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 p m —Mr R Hills 'Use of Wind Tunnel Model Data in Aerodynamic Design"

Society of Chemical Industry, Food Group (joint meeting with the Northern Ireland Section, in the Agricultural Chemistry Department, Queen's University, Elmwood Avenue, Belfast), at 7 30 p m — Dr J B M Coppock "The Application of Science in the Baking Industry"

### Friday, October 20

Biochemical Society (at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N W 7), at 11 a m —Scientific Papers

British Mycological Society (joint meeting with the Association of Applied Biologists, in the Main Lecture Theatre, Huxley Buildings, Imperial College of Science and Technology, Exhibition Road, London, S W 7), at 11 a m —Discussion on "The Plant and the Law"

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 3 p m —Annual General Meeting.

Chemical Society, Birmingham Section (joint meeting with the University Chemical Society, in the Chemistry Department, The University, Edgbaston, Birmingham), at 4 30 p m —Dr E J Bowen, F R S "Chemistry and the Scattering of Light"

Chemical Society, St Andrews and Dundee Section (joint meeting with the St Andrews University Chemical Society, in the Chemistry Department, United College, St Andrews), at 5 p m — Prof J Read, F R S 'Historical Science as an Instrument of Culture"

Council for the Promotion of Field Studies (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 p m — Annual General Meeting, Mr M C Burkitt "Archæology, Education and Field Work"

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London S W 1), at 5 30 p m —Dr S F Dorey Presidential Address

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne), at 6 15 p m —Annual General Meeting, Sir Philip Johnson Presidential Address

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p m —D[illegible] H L Penman "The Role of Vegetation in Meteorolog[illegible] Mechanics and Hydrology"

Chemical Society, Aberdeen Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, Marischal College, Aberdeen), at 7 30 p m —Dr R Hurst "Recent Work on the Transuranic Elements"

### Friday, October 20—Saturday, October 21

Institute of Biology and the Atomic Scientists' Association with the support of the British Association (at the Royal Institution, 21 Albemarle Street, London, W 1) —Conference on "The Biological Hazards of Atomic Energy"

**Friday, October 20**

At 10 a m —"Biological and Medical Effects of Nuclear Radiations", at 2 15 p m —"Tolerance Levels and Measures of Protection"

**Saturday, October 21**

At 10 a m —"Biological Implications", at 2 15 p m —"Atomic Energy and the Future"

### Saturday, October 21

British Psychological Society (in the Eugenics Theatre, University College, Gower Street, London, W C 1), at 2 30 p m —Dr J C Flugel 'The British Psychological Society"

RP R 294

## APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Chemist to carry out investigations on the problem of spray retention on foliage, at the Long Ashton Research Station, on behalf of the Colonial Insecticides Committee—The Secretary, The University, Bristol (October 21)

Deputy Generation Design Engineer in the Chief Engineer's Department at London headquarters—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W 1, quoting Ref AE/100 (October 21)

Lecturer in Mathematics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S E 18 (October 21)

Research Assistant in the Department of Economics and Commerce, to undertake research upon the wool trade—The Registrar, The University, Leeds 2 (October 21)

Senior Hospital Physicist for the new radiotherapy department at the Churchill Hospital, Headington—The Administrator, Radcliffe Infirmary, Oxford (October 21)

Teacher (temporary, full-time) of Chemistry—The Principal, Norwood Technical College, Knight's Hill, London, S E 27 (October 21)

Assistant in the Medical Department, London headquarters, to be Junior Editorial Assistant on the staff of the *British Medical Bulletin*—The Director, Personnel Department, British Council 65 Davies Street, London, W 1, endorsed 'Medical' (October 23)

Senior Lecturer in Chemistry—The Principal, Chelsea Polytechnic, Manresa Road, London, S W 3 (October 23)

Senior Assistant Engineer on the staff of the Chief Engineer to the Devon River Board—The Chief Engineer, County Surveyor's Office, New North Road, Exeter (October 24)

Senior Lecturer in Bacteriology, and an Assistant Lecturer in Biochemistry, at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (October 31)

Analyst to take charge of the Chemical Laboratory connected with Crop Testing—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Civil Engineer by the Nigerian Government Electricity Undertakings—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M N 25440/3A

Civil Engineers and Surveyors for road and bridge construction and for location surveys, by the Public Works Department of Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, London, S W 1, quoting No 27322/191

Electrical Engineers (electrical distribution) by the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M N 25016/3B

Head of the Mechanical Enginee[illegible]g [illegible]epartment—The Clerk and Treasurer, Dundee Technical College, 40 Bell Street, Dundee

Lecturer in Metallurgy at the County Technical College, Wednesbury—The Director of Education, Department F E, County Education Offices, Stafford

Mechanical Engineer (Ref M N 25450/3B), and an Electrical Engineer (hydro-electric) (Ref M N 25728/3B), by the Centra Electricity Board, Federation of Malaya—The Crown Agents for th Colonies, 4 Millbank, London, S W 1, quoting the appropriate Ref No

Physicists (4) interested in fundamental research on the properties of matter—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester

Professor of Anatomy, a Professor of Radiology, and Professor of Pharmacology, by the Government of Iraq for t Royal Hospital and Medical College—The Crown Agents for t Colonies, 4 Millbank, London, S W 1, quoting M S A 922/5/3F

Senior Scientific Officers and Scientific Officers in vario Government Departments, and for a wide range of scientific rese and development in most of the major fields of fundamenta applied science—The Secretary, Civil Service Commission (Sci Branch), 7th Floor, Trinidad House, Old Burlington Street, Lo W 1, quoting No 2887

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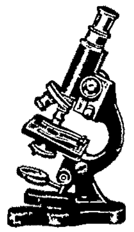

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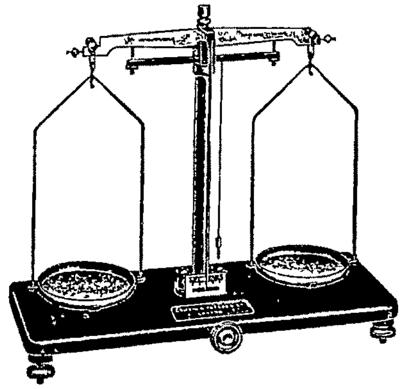

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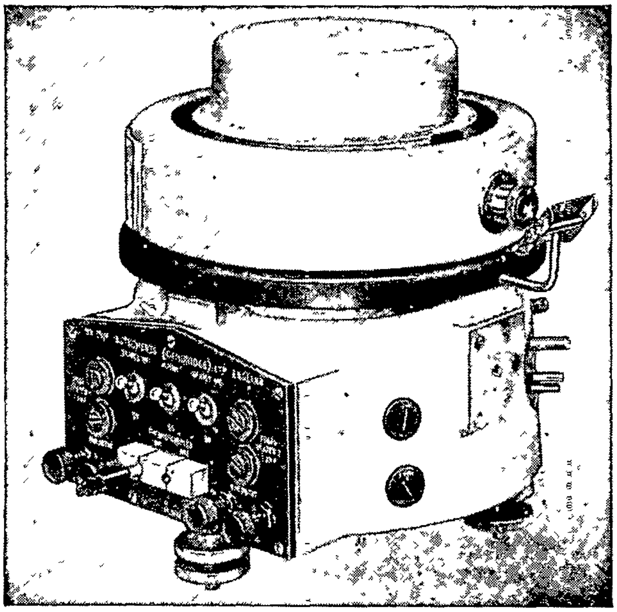

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# EXPANSION OF TECHNICAL EDUCATION : NUMBERS AND QUALITY

IN its third annual report, issued last July, the Advisory Council on Scientific Policy emphasized that the maintenance and improvement of the position of British industry in the world would involve a continuing and growing demand for men of the highest scientific attainments, both on the technical and on the administrative side in industry At the same time, it gave the full weight of its authority to the early establishment, in the university system of Great Britain, of one or more colleges of applied science, with suitable governing bodies of their own In addition, the Parliamentary and Scientific Committee has followed up its earlier report (of 1947) on colleges of technology and technological man-power, with one on technical education and skilled man-power* At the end of July, when Sir Henry Tizard was addressing the Committee, he both commended this report and referred to the observations on technological education of the Advisory Council on Scientific Policy While he believes there should be more institutions of the highest class devoted to research and education in technology, he does not himself consider it necessary for them to be part of a university Afterwards, like Sir Harold Hartley, Sir Henry contributed to the debate on September 4 in Section L (Education) at the British Association meeting in Birmingham, which followed a paper by Sir Ewart Smith on the critical importance of higher technological education in relation to productivity, again urging the importance of a steady increase in the number, standard and prestige of technologists in all branches of industry, in the Dominions and Colonies as well as in Great Britain In the course of the debate on defence in the House of Commons on September 13, Sir Ralph Glyn referred to the scarcity of technical man-power in the Services themselves, and said it is the result of an insufficient number of technical colleges and schools In the later debate on the National Service Bill, Mr McCorquodale made a like point in reference to the possible effect of the Bill on technical training

Sir Ewart Smith, speaking at Birmingham, said he does not think that the means by which the higher technological education system is expanded, whether within the universities or by the creation of new institutes of technology, matters, so long as standards and balance are maintained The increase in both the numbers and the quality of our resources in man-power in the field of applied science, in his view, should come by the natural growth and evolution of our existing institutions His concern is rather with the quality of the education that is given whatever the means adopted, the important thing is to ensure that the student is taught to think and to see his technology in its context, if not, indeed, as part of a general pattern of culture against which Dr Eric James has suggested the teacher should see his subject

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* Parliamentary and Scientific Committee Technical Education and Skilled Man-Power Pp 20 (London Parliamentary and Scientific Committee, 1950 ) 1s 3d

Whatever the means adopted, Sir Ewart said, the main increase in numbers is required in engineering and related technologies, which are the basis for the conversion of scientific knowledge to effective use in every type of industry He believes that the difference in the relative numbers of those trained in applied science in Great Britain and the United States has been responsible for the difference in rate and efficiency with which scientific and technological knowledge is now being applied throughout industry in the two countries, and has also led to a lower overall standard of scientific approach and understanding in Great Britain in the whole field of management as affecting industrial affairs Analysis of the main factors which determine industrial efficiency indicates that the rate at which productivity will increase depends primarily upon the evolution and application of new technical knowledge This in turn, depends upon the numbers and quality of the technologists available, upon the ability of industry to apply new knowledge by the expenditure of capital, and upon the willingness of the community to improve permanently future standards of life at the expense of some current saving in consumption

The progress of industry, and therefore the economic position of the nation, mainly depend, in Sir Ewart's view, upon technological skill in application, and he is disturbed to find that, in spite of the doubling of the output of British universities in comparison with pre-war years, there has been no improvement in the proportion of those trained in applied science The ratio of degrees in applied science to those in pure science in 1949 was no greater than in 1925 Sir Ewart recognizes that the output of applied scientists must to some extent be determined by the industrial demand , but he urged that industry should be encouraged to call for and use men who have had higher technological training, and that the rate of output should be steadily increased to match this growing and cumulative demand There is a clear need in all walks of life, he said, for a proper proportion of men who have had an education to university standards, and particularly on the scientific side

This emphasis on the aspect of quality in relation to the expansion of higher technological education may have led Sir Ewart's audience to overlook the full significance of his emphasis on the need for steadily continuing expansion He himself, moreover, fully recognized that the fruits of such expansion can only be realized if the education of the population generally is such that the significance of scientific and technical factors in industry and in political and economic affairs is more clearly appreciated That aspect was indeed fairly well explored in another discussion at the British Association meeting, at which Dr Eric James took the place of Dr J B Conant and spoke of the initiation of the arts student into scientific thought, including both method generally and elementary scientific work

Nevertheless, an objective of increasing the overall national productivity of Great Britain by not less than 5 per cent per annum for many years to come implies, on Sir Ewart Smith's thesis, an immediate addition of nearly 1,500 per annum to the present 27,000 full-time students in pure science and technology, and a larger increment as the years pass A continuing expansion on that scale in university and higher technological education must have [illegible]her effects Unless the increased number of technologists is secured to some extent by a reduction of the members graduating in pure science, the arts and other faculties, a point will be reached at which it will be necessary to consider more closely whether there are sufficient reserves of talent to profit adequately by training of a university standard at the public expense The effect of such expansion on the supply of technicians and the general upgrading of the technical training of all the industrial man-power of Britain also require consideration Sir Ewart Smith, in his paper, referred to the importance of this latter factor, though not to the necessity for striking a balance between the numbers of technicians and technologists

The quantitative aspect of this problem is not given much consideration in the two reports from the Parliamentary and Scientific Committee, the first of which seems disposed to accept the output of 6,000–7,000 technologists and scientific workers envisaged in the report of the Percy Committee, and which apparently overlaps to some extent with the 3,303 applied scientists now coming from the universities —there are at present roughly 11,000 full-time students of technology in the universities The reports are, indeed, concerned primarily with the question of quality and with the means by which this potential capacity can be most effectively utilized In the earlier report, the Committee does not distinguish sufficiently between the training of technologists and the training of technicians , but in its second report, that distinction is drawn more clearly It is recognized that the future scientific and technological development of the industries of Britain depends both on the ability of the technologists and those occupying posts of high responsibility, and also on the training and skill of the rank and file The Committee refers, for example, to a report of the Medical Research Council published in 1944, which indicated that a serious dislocation in output accompanying changes in the type of product would hav been avoided or reduced by more adequate training and consequent greater adaptability through greater familiarity with materials, confidence in the use of machinery and a knowledge of the part the worker's operation had played in the manufacture of the whole product It quotes again the observation in the White Paper on Educational Reconstruction that, with the fading of the initial and natural advantages that gave Great Britain, almost for the asking, its pre-eminence in world manufacture and world markets, it will become more and more necessary to rely on the capacity, adaptability and quality of our industrial and commercial personnel

The Committee points out that, in order to realize the full effect of increasing the number of technologists employed in industry, either in productivity or in the speedier translation of research results into industrial practice, it is essential for technologists to have under their direction skilled men capable of directing and running the new processes and of conferring with the technologist on problems which are bound to arise in the step from experimental to large-scale production Skilled and well-trained men are less likely to resist changes essential to progress, rather they are frequently enthusiastic in bringing their work to a successful conclusion Full industrial efficiency, in fact, requires personnel at all levels to show an intelligent appreciation of and response to the complex and rapidly changing techniques of modern production

In these observations the Parliamentary and Scientific Committee shows awareness of a factor which was virtually ignored in the discussion which followed Sir Ewart Smith's paper at Birmingham However much a more widespread and efficient system of technical education can do to dispel it, the recent dispute at the Wernett Mill, Oldham, is a reminder of a temper and outlook among trade unions which can offset any advantages in productivity to be gained by new machinery The adjustment of working methods demands not only a higher standard of technical education, but even more a new outlook and attitude on the part of the workers While the importance of the human factor in productivity was fully recognized in the discussion at Birmingham, not enough stress was laid on what is, in part at least, a psychological problem and one to which trade unions as well as educationists must turn if industrial productivity and efficiency are to be advanced, and with them standards of living raised, or even maintained

## WHY RUBBER IS 'RUBBER'

### The Physics of Rubber Elasticity

By L R G Treloar (Monographs on the Physics and Chemistry of Materials ) Pp vii + 256 (Oxford Clarendon Press, London Oxford University Press, 1949 ) 21*s* net

IN these days one's first reaction to any new book is Does it fill a real need ? Of Dr L R G Treloar's book one can say at once that it does Rubber is not only an important class of industrial material, but it also represents virtually a fourth state of matter—not solid, not liquid, not gas Rubber, therefore, has a physics of its own, without an understanding of which its remarkable elastic properties can never be fully utilized Fortunately, the subject has during the past fifteen years attracted many able physicists, who have built up an impressive structure of knowledge in this new field Dr Treloar's book, as the first comprehensive account of these developments, is thus of great importance, both to the rubber technologist and to the physicist desiring to investigate this intriguing subject further

The fundamental concept of the new rubber physics is the statistical (or statistical-kinetic) origin of the force in stretched rubber Whereas in an ordinary solid this force is due to deformation of inter-atomic bonds, in rubber it is due to rearrangement of the randomly kinked long-chain molecules into straighter forms with lower entropy The first seven chapters of the book describe the gradual development and refinement of this theory and the comparison of its predictions with experimental data The story is a fascinating one It is perhaps not generally realized that the basic idea was put forward as early as 1855 by Kelvin, although further progress was not made until 1932–33 The story is not yet complete, and important further advances may be expected from the line of approach used by Mooney (1940) and developed by Rivlin, based on the stored-energy function rather than the force as the basic parameter, characterizing a deformation

The second half of the book shows how various aspects of rubber deformation fit into the statistical theory or require its predictions to be modified These are photo-elastic properties (Chapter 8), neatly explained by the theory and yielding valuable data for its further development, crystallization in rubbers and its effects on mechanical properties (Chapters 9 and 10), the main effect being a departure from 'statistical' elasticity, stress relaxation and flow (Chapter 11), dynamic properties (Chapter 12), solution of problems involving large elastic strains (Chapter 13—which might better have followed Chapter 7) Chapters 10-12 show that these aspects of rubber deformation are far less understood than simple elastic deformation Thus, no one yet seems to have explained why crystallization increases tensile strength (Chapter 10), and Chapters 11 and 12 clearly show the need to study flow and other technically important time-dependent deformations on lines analogous to those which have so successfully explained elastic deformation Here, then, is a new challenge to the physicist

Dr Treloar's lucid style makes his book easy reading, and the fact that his own and his colleagues' researches form not a little of the subject-matter explains his mastery of it The author's attempt to deal with the subject "in not too mathematical language" has succeeded admirably, and the readers for whom the book is intended—"physicists in universities and in government and industrial laboratories"—should have no difficulty whatever The rubber technologist may regard the statement (p 184) that "the carbon particles are evidently capable of taking over the function performed by the crystallites" as an over-simplification, or does it suggest a novel approach to explaining reinforcement ? Errors seem remarkably few neoprene is a *crystallizing* rubber (p 191), "1 05 $\times$ $10^6$" should be "1 1 $\times 10^{12}$" on p 195, line 8 from bottom

The paper, printing and binding are fully worthy of the contents of a book on which both author and publisher are to be congratulated J R SCOTT

## A NEW MARINE NATURAL HISTORY

### Natural History of Marine Animals

By G E MacGinitie and Nettie MacGinitie Pp xii + 473 (New York and London McGraw-Hill Book Co, Inc, 1949 ) 36*s*

THIS volume is an important and refreshing addition to the literature on the interrelationships of marine animals in general, and it is all the more valuable in that most of the animals mentioned are from the relatively unknown littoral and offshore waters of the Pacific coast of North America There are many points which will be of interest to marine biologists in Europe as, for example, the striking predator/prey reaction between a starfish and a sand dollar urchin. In Great Britain the flight reaction initiated among groups of the small scallop (*Pecten opercularis*) by the physical and chemical presence of the common starfish is now fairly well known. Off the Californian coast the presence of another predatory starfish causes immediate burrowing of all the sand dollars in its vicinity.

The arrangement of the main subject-matter is systematic, enabling the reader to study the comparative ecology of a group rather than of a habitat. It is in these main sections that the authors have packed such a wealth of material on the general biology of the Pacific coast species. Much of this factual matter would appear to be derived from the writers' own observations, and it is perhaps unfortunate that the reader cannot readily distinguish the new from the old, owing to the lack of references.

The book contains excellent chapters on such general subjects as food, animal groupings and sense organs, and there is a stimulating discussion on growth-rate, a subject which is difficult to analyse in a population of marine animals, and upon which it is perhaps even more difficult to generalize. Records are given of some careful experiments on the growth of a colonial tunicate, from which the authors were able to calculate the frequency of division in a colony and the overall growth in unit time under varying conditions. The book ends with a chapter on the relation of higher vertebrates to shore conditions, and there are appendixes giving a short bibliography of general works, and an original analysis of animal phyla according to the types of habitat in which their representatives live.

The authors have written a stimulating book of value, packed with observations on the mode of life of marine animals, which shows that real natural history is still a very live subject.

H. G. VEVERS

# SWEET ODOURS

## Synthetic Perfumes

Their Chemistry and Preparation. By Dr. T. F. West, Dr. H. J. Strausz and Dr. D. H. R. Barton. Pp. viii+380. (London: Edward Arnold and Co., 1949.) 70s. net.

THE chemistry and preparative methods of the important perfumery synthetics are described systematically and factually in this book. It is one that should be a useful text-book for the manufacturer of perfumery chemicals, and a guide that will show the artist-perfumer what raw materials are available to him. It is a book in which the chemistry is uniformly sound and the nomenclature careful; in these respects it shows a considerable advance over some of its predecessors in the same field.

Some resolution is always needed to re-write material, but when an author is confronted with new information which disturbs what he has already written, he should not evade the task. Drs. T. F. West, H. J. Strausz and D. H. R. Barton have taken a rather different line in one or two instances. Their discussion of irone (pp. 178–185) was evidently written before October 1947, when both Ruzicka and Naves described its synthesis in *Helvetica Chimica Acta*. In fact, the "probable formula" of irone which is given on p. 178 of "Synthetic Perfumes" includes a 7-atom ring. The description of the synthesis and true constitution of irone is given on p. 336 in an addendum, which also includes a discussion of recent work on muscone and civetone. One cannot help thinking that it would have been far better to have incorporated this important new material in the body of the book, even at the cost of re-writing a part of it.

Perhaps it is because of the plurality of authorship that occasional cases of repetition are to be found; for example, the superiority of ethylvanillin to vanillin itself for use in the presence of methyl anthranilate, which is adequately described on p. 133, is repeated on p. 289.

Finally, it is to be deplored that technical books tend increasingly to cost more than most individuals can afford to pay for them.

R. W. MONCRIEFF

# THERMODYNAMICS FOR THE ADVANCED ENGINEERING STUDENT

## Thermodynamics

Principles and Applications to Engineering. By Prof. Dr. Ernst Schmidt. Authorized translation from the third German edition, by J. Kestin. (Oxford Engineering Science Series.) Pp. xx+532. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 35s. net.

AT a first glance, this appears to be a book to be warmly welcomed, including, as it does, subjects of topical interest such as supersonic flow, jet-propulsion and even a paragraph on heavy water. However, on reflexion, doubts arise as to the possibility of covering the whole ground to the same high standard in a not too unwieldy volume, starting with yet another re-statement of elementary points. Investigation reveals that there is some selective treatment and omission of points which possible purchasers of the book might reasonably expect to find dealt with.

If the subject of fluid mechanics is to be admitted to a book on thermodynamics—and it seems inevitable nowadays—surely there are numerous problems connected with internal combustion engines coming under this heading; admittedly these are dealt with at some length in other books of this series. In Great Britain, Callendar's equation might be considered worthy of more attention than a short paragraph (and that somewhat derogatory). In fact, the basis of the steam tables (Keenan and Keyes) given at the end of the book is scarcely explained adequately. Kinetic theory is not dealt with separately but is developed as required alongside the rest of the subject. This perhaps is as it should be, but the author just misses going far enough to throw light on certain phenomena: for example, the laws of expansion of steam under particular conditions remain an unresolved mystery to a reader of this book, the appropriate formulæ being merely referred to as empirical—an almost inevitable corollary to ignoring Callendar's work. Again, in turbine work, scant recognition is accorded to the contribution of workers in Great Britain, and, where practice here is at variance with or even in advance of that given, no hint as to the facts is indicated.

A brave attempt is made to cover the subject of heat-transfer in its higher flights in two chapters, with inevitable gaps. For example, the author's method of solving the unsteady-state conduction problem receives prominent attention; but no mention is made of other methods of tackling these problems The Fourier analytical solution of the general unsteady-state equation is omitted On the other hand, the application of the theory of similarity to heat-transfer problems is presented mathematically, but only in a manner which will conceal its importance from the reader not well equipped in that direction The radiation of both non-luminous gases and luminous flames is not dealt with

Notwithstanding these criticisms, there is a vast amount of careful, clear and painstaking explanation of various aspects of the subject The more advanced sections, however, are open to the criticism that usually the German method of treating the various problems is given however excellent, a comparison with methods more familiar in Great Britain would be valuable In general, the book follows many others of Continental origin in appearing to imply that any reasonably competent person reading from the beginning to the end can become an expert in the subject, whereas in actual fact all too many find they have a ceiling beyond which they cannot rise There is no indication to such as to which are the important points

Summing up, it may be said that this is a valuable and useful contribution to the literature of the subject in the English language, if read in conjunction with other books or under suitable guidance

A L BIRD

## GAS TURBINES

### The Theory and Design of Gas Turbines and Jet Engines

By Prof E T Vincent Pp ix + 606 (London McGraw-Hill Publishing Co , Ltd , 1950 ) 64*s*

IN a world already sated with technological literature, if an author feels it impossible to resist the urge to go into print, it is surely his first duty to be as concise as possible A student to-day has not the time to separate out the essentials and the irrelevancies in a text-book The gas turbine is a particularly suitable subject for the practice of precise writing, for, in the elementary forms in which it should be presented to students, it is one of the simplest heat engines that can be conceived It should be possible to convey the essential facts about it in some two hundred pages of normal text-book size

The author of this book, however, has decided to leave nothing to chance and plugs away at his subject for three times as long By the time he is through, the exhausted reader, in addition to having a miscellaneous collection of basic formulæ in his head, has had to absorb a mass of irrelevant details of obsolete engines This practice of mixing up the fundamentals of a subject with examples of current or out-of-date applications of the fundamentals and with details of practical points connected with the operation of the main and ancillary machinery is a common fault in modern text-books In fairness to the author, it must be added that this book is certainly no worse than many others on the same subject

The book is at its best when dealing with the straightforward dynamics of flow in compressors and turbines, although much of the material appears to have been taken almost bodily from the author's sources The chapter on combustion consists mainly of a description of existing chambers and techniques, with little of the underlying theory Chapters are also included dealing with jet propulsion, in which the arithmetic of the propulsive jet is very fully presented, with materials, including miscellaneous data on a number of materials, some of which are of interest to engineers at the present time , and with regenerators, in which some useful formulæ for calculating heat flow are given without really getting down to the kernel of the heat exchanger problem The book would gain very greatly if the author had given physical explanations of the phenomena occurring instead of usually remaining content with presenting the bare mathematical equations

The standard of gas-turbine text-books is so very low that, in spite of the hard words written above, this book is probably one of the best so far produced on this subject But we still have to wait for a work on the gas turbine equivalent to D R Pye's classic volumes on the internal combustion engine

H CONSTANT

## SCIENCE AND LITERARY CRITICISM

### Science and Literary Criticism

By Prof Herbert Dingle Pp viii+184 (London and Edinburgh Thomas Nelson and Sons, Ltd , 1949 ) 7*s* 6*d* net

THE author has performed a valuable service in writing this short but stimulating book It divides naturally into two parts the first debates the question as to whether a science of criticism is possible—and the short answer is "scarcely", whereas in the second, some illuminating comments are made on the work of three poets to illustrate the way in which a scientific *Methodik* might help

Although Prof Dingle does not remind his readers that a 'poet' originally meant a 'maker', it may be hoped that they will recollect this derivation and keep it before them, for it adds weight to these penetrating analyses of Wordsworth, Swinburne and Browning It is no use, we are told, to revel in the beauty of a poem if we would try to be critics we only discover ourselves that way, and not the poet Wordsworth sought happiness first—a blissful enjoyment impervious to detail Such an outlook is not inconsistent with his idea of truth, which is more akin to dreaming than to intellectual veracity

By contrast, the problem of Swinburne is to discover his 'vectors' which point outwards from his 'internal centre', about which, aforetimes, Meredith and Mrs Meynell were rather unkind It is seen, however, to be an exceedingly complex phenomenon, connected in some way with a passion for the infinite In this context, the contrast with Shelley's psychological constitution is well brought out.

Finally, the intellectuality, or its absence, of Browning is reviewed, and it becomes manifest that the reply to the query whether he was scientific is "definitely not"

Much of all this is applicable to the arts in general for example, Browning's incapacity to generalize puts him, in this respect, in company with Leonardo da Vinci who, in spite of his inventive powers, lacked scientific, and still more mathematical, ability in the fundamental sense Such matters will interest a wide circle, and this scholarly contribution deserves the warmest of welcomes

F I G RAWLINS

## Lord Lister, his Life and Doctrine

By Douglas Guthrie Pp viii+128+21 plates (Edinburgh E and S Livingstone, Ltd , 1949 ) 15*s* net

THE serious student of Lister's life and work has abundant sources of information available in such books as Sir Rickman Godlee's standard "Life of Lister" (1917, revised edition 1924), Sir William Cheyne's "Lister and his Achievements" (1925), the "Lister Centenary Exhibition Handbook" of the Wellcome Historical Medical Museum (1927), H C Cameron's "Joseph Lister the Friend of Man" (1948), and Lister's "Collected Papers" (1909) Some of these, and other classical biographies, are out of print and not easy to obtain The medical student, the medical practitioner and the layman will be grateful to Dr Douglas Guthrie, lecturer on the history of medicine in the University of Edinburgh, for providing them with a small, readable, attractively produced, modestly priced and up-to-date addition to the literature

To the medical historian the most valuable feature of this book will be the inclusion of autograph letters in the possession of the University of Edinburgh and of the Royal College of Surgeons of England, published here for the first time, particularly one letter in which Lister suggested that *Penicillium* might influence the growth and activity of bacteria The story of this is told in the *Annals of the Royal College of Surgeons of England* (6, 140 , February 1950), with comments by Sir Alexander Fleming

The author's excursions into contemporary history, medical and general, and his pleasing pen-portraits of such men as James Syme will be welcomed by the reader, who will also appreciate the conveniently short sections and the copious subheadings "1914" on p v should read "1917", and "1886" on p 62 "1868" W R Bett

## An Annotated Checklist of the Birds of Malaya

An Annotated List of the Birds occurring, or known to have occurred, in the Territories of the Federation of Malaya and the Colony of Singapore By C A Gibson-Hill (Bulletin of the Raffles Museum, Singapore, No 20 ) Pp 299 (Singapore Raffles Museum, 1949 ) 5 dollars , 12*s*.

THIS present volume is the fourth hand-list of Malayan birds published in the course of the past forty years The two first were published by H C Robinson in 1907 and 1910, and in 1925 F N Chasen brought out his "Handlist of the Malaysian Birds", the last including Borneo and Sumatra, etc This new volume differs considerably from its predecessors and should be very useful to the increasing numbers of bird students in the Peninsula The area covered does not extend beyond the northern boundary of the Federated States, whereas in the former volumes part of Peninsular Siam as far as the Isthmus of Kra was included This change the author considered necessary because there was not sufficient information available on the different species in the area between these two boundaries

The distribution is given in some detail, and in the short paragraph under each species the author has added brief notes on the type of country inhabited, status within the area, whether the nest is known, and the reason for adding or omitting certain species or races Mr C A Gibson-Hill is to be congratulated on the way he has prepared the list, and, considering that he only joined the Singapore Museum in 1946, this is a remarkable piece of work In his treatment of some species or races he is not always very happy, but it must be remembered that he has had to depend to a great extent on the views of others

The spelling of the English names does not follow the usual custom, and may be an attempt at Basic English, but, possibly because I am old-fashioned, I prefer the spelling used by Chasen It is to be hoped that the author, in spite of the present warfare in the country, is collecting material for a handbook of the birds of the Malay Peninsula Robinson's volumes are too large and unwieldy, and unfortunately he was no field naturalist so that details of habits and breeding, etc , are lacking in his books

N B Kinnear

## Metallurgical Abstracts (General and Non-Ferrous)

Editor Lieut -Colonel S C Guillan , Assistant Editor, Major W G Askew Vol 15, 1948 Pp viii+750 (London Institute of Metals, 1948 ) £3

THE outstanding characteristic of these abstracts of the Institute of Metals is their unvarying excellence The ground covered may be realized from the facts that there are 624 pages—with probably something of the order of six abstracts per page—and that the subject index extends to more than seventy pages The papers dealt with are adequately and expertly summarized, and there is no difficulty in getting a detailed idea of the ground covered and the sort of results obtained

Perhaps one of the most surprising features of the volume is the range of publication examined , not only are the outstanding scientific journals included in the reviews, but also a very large number of others, the very names of which will be unknown to many The care with which overseas literature has been examined appears to be as adequate as that of British publications In addition to the formal abstracts, there are reviews of books dealing directly or indirectly with the interests of the Institute, and a bibliography of books, specifications, reviews, etc , which covers a wide field Within the limits of the Institute's sphere, it is difficult to believe that a more adequate abstracting service could be provided

F C T

## Foundations of Modern Physics

By Prof Thomas B Brown Second edition Pp xvi+391 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 30*s* net

IT is natural that in a book which covers a wide field, including electronics, nuclear physics and the theory of elementary particles, major revisions and additions were necessary in preparing a second edition of Brown's "Physics", the first edition of which appeared in 1940 An introduction and epilogue have been added in which the objectives and philosophy of the book are explained The emphasis throughout is upon the experimental aspect and upon the evidence which these experiments give in support of the theories whereby the results are interpreted and explained

The book is intended for the non-specialist and should stimulate his interest for further reading and study To help him, every chapter concludes with a list of carefully selected references divided into two groups consisting of less and more advanced texts The book is excellently produced with numerous clear diagrams and interesting photographs It should be in every university library and in many school sixth-form libraries S Weintroub

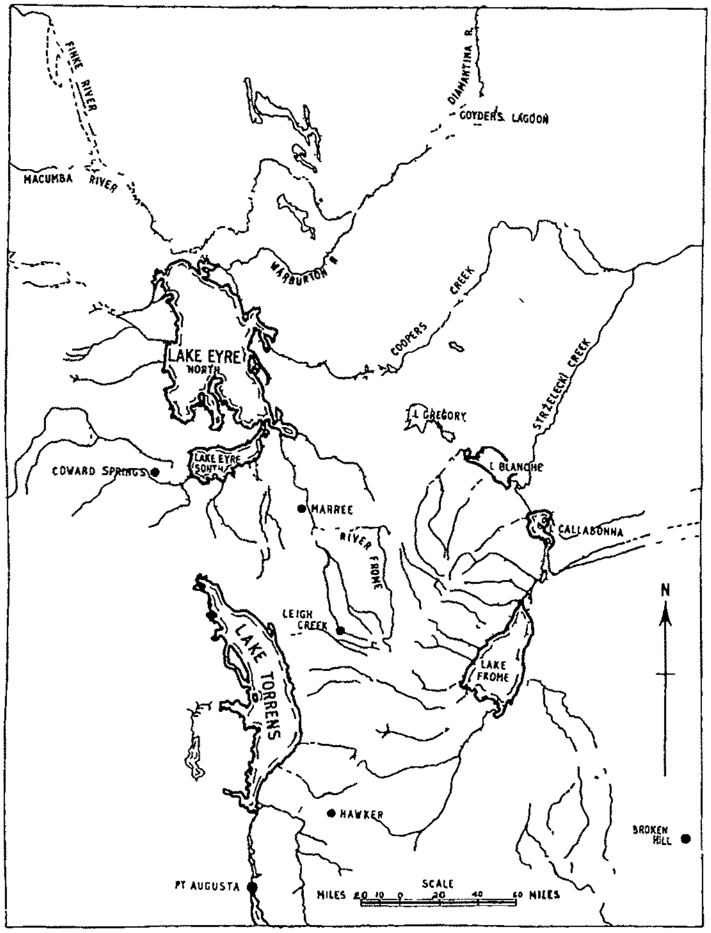
# OCCURRENCE OF WATER IN LAKE EYRE, SOUTH AUSTRALIA

By Sir DOUGLAS MAWSON, O B E, F R S

University of Adelaide

INDISPUTABLE evidence of the existence during Pleistocene times of extensive lakes in the north-eastern portion of South Australia has long been recognized by Australian geologists Lake Eyre and Lake Frome and other minor salinas of that region are but the dried-up shrunken remnants of that formerly extensive body of water It was fed by a number of once great rivers rising as much as a thousand miles away in the western highlands of Queensland At its greatest extension, the area of this palæogeographic feature was possibly of the order of very many thousands of square miles It derived its name, Lake Dieri, from that of a tribe of aborigines who formerly inhabited the country to the east of Lake Eyre In some localities, the limits of the former lake are clearly defined by former shore-level terraces

Since White occupation, these lakes have been dry, or at the most have received only rare and ephemeral contributions of water, the last of any note being about fifty-six years ago The dry bed of Lake Eyre is about sixty or more feet below sea-level In the heyday of Lake Dieri, there must have been a depth of several hundreds of feet of water, for it overflowed into Lake Torrens and thence to the sea at Port Augusta on Spencer Gulf



In the pluvial period of the Australian Pleistocene, this great inland sheet of water was mainly fed by long rivers flowing south-west from the western slopes of the east-coast ranges of tropical Queensland Of these the main relics now existing are the intermittently flowing Diamantina and Cooper Creeks Other though less important contributions were forthcoming from the north-west by way of the Finke and the Macumba Rivers In the Pleistocene, crocodiles of north Queensland origin inhabited Lake Dieri, and gigantic herbivorous marsupials occupied the surrounding country, which had a thick plant cover Now all that remains of that once virile population is their fossilized remains occasionally met with in the lacustrine sediments

The floors of the saline remnants of the old lake are occupied by gypseus and saliferous muds Some years ago, the late Dr C T Madigan found an upper crust of 17 in of salt on the saliferous muds of Lake Eyre

During the past two years the incidence, distribution and amount of rainfall in Australia have been exceptional Most notable has been the unusually heavy and sustained rainfall in the eastern States, and in none more marked than in Queensland There has been a remarkable flooding of the western plains of Queensland The normally dry channels of the once great rivers, for example, the Diamantina and Cooper, have sprung to life again and are pouring vast quantities of water into the bed of Lake Eyre Transport has been dislocated over wide areas and the occupants of sheep and cattle stations marooned

Several South Australian pastoralists have recently returned from an investigation of the present state of Lake Eyre They report flood waters extending far beyond the main channels of the rivers entering the lake In the case of the Cooper, the swirling current in the main channel was found to be moving south at the rate of about four miles an hour. The Lake, when last reported, was a vast sheet of water, fresh and muddy where the rivers entered, but elsewhere salt By means of a boat transported to the Lake, the muddy shore waters with a depth of a couple of feet were found to pass into clear saline waters with a depth of up to 12 ft at a distance from the coast

Viewed from the air, occasional small islands were observed in the body of the lake The carcases of creatures such as rats, insects and the like, drowned by the floods, were found to have attracted vast numbers of water birds, particularly pelicans and ducks of every description, but also flocks of seagulls and cormorants that had travelled far inland to partake of the orgy

Everywhere the surrounding country, normally a veritable sandy desert, is now clothed in a wonderful growth of Mitchell grass, cane grass, wild geranium, acacias and abundance of wild flowers, of which everlastings are most obvious.

Surely no better example has been recorded of the sudden transformation of a desert to comparative fertility consequent on a temporary, perhaps cyclical, variation in the local atmospheric circulation.

# SURVIVAL OF SPERMATOZOA AT LOW TEMPERATURES

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IT is well known that some organisms have a remarkable capacity for surviving exposure to very low temperatures, and certain facts stand out clearly from the extensive literature reviewed by Luyet and Gehenio[1]. Organisms which can withstand desiccation are able to revive and resume growth and reproduction after cooling, in the dried state, to temperatures close to absolute zero. Some other cells will survive without desiccation provided that they are cooled and afterwards warmed so rapidly that the protoplasm is vitrified and thawed without formation of ice crystals. Luyet believes that the preservation of life at low temperatures depends on preventing the formation of intracellular ice crystals, either by dehydrating the cells before freezing, or by ultra-rapid cooling and rewarming. A variety of living organisms including certain bacteria, yeasts and fungi can, however, be revived from very low temperatures without preliminary desiccation, whether cooled slowly or quickly. Other cells in the wet condition, for example some trypanosomes, trichomonads, microfilaria and hookworm larvæ, survive slow cooling to −70° C. better than quick cooling[2]. For the survival of leukæmia cells[3], and the active forms of nematodes, rotifers and tardigrades[4], slow cooling is essential.

Spermatozoa show great differences from species to species in their resistance to low temperatures, and not only the rate of cooling but also the medium in which they are suspended influence the proportion reviving. Thus, fowl semen undiluted, or in Ringer's solution, shows no motile spermatozoa after freezing either quickly or slowly to −79° C. or −196° C., whereas when the semen is diluted to contain 20 per cent glycerol the spermatozoa resume full motility after cooling to, and storage at, −79° C.[5]. Slow cooling is only necessary when the glycerol-containing semen is frozen in thin-walled capillary tubes or films[6]. In protecting the spermatozoa against low temperatures glycerol appears to be outstanding. Among the large number of polyhydric alcohols and their derivatives so far examined by us, only ethylene and propylene glycol in final concentrations of 15 or 20 per cent will permit normal motility of fowl spermatozoa and give revivals approaching those with glycerol. Other substances, for example, the α- and β-methyl ethers of glycerol, diethylene and trimethylene glycol, and the monomethyl and monoethyl ethers of ethylene glycol, are more toxic and give less protection against low temperatures.

The spermatozoa of most mammals have proved more sensitive than those of fowl to rapid cooling. Human spermatozoa are exceptional, for even in undiluted semen a proportion will withstand exposure to the temperatures of solid carbon dioxide, liquid nitrogen and liquid helium[7,8], although the revival can be improved both by increasing the volume frozen[9], which presumably decreases the rate of cooling, and by dilution to contain 5 per cent glycerol or 5 per cent propylene or ethylene glycol[5]. By contrast, the revival of bull and goat spermatozoa depends both on dilution of the semen to contain a final concentration of 15 per cent glycerol in a citrate buffer solution, and on slow cooling, taking at least 40 min. to pass from 0° C. to −79° C.[10].

According to our present experience, horse spermatozoa are more difficult to revive from low temperatures; they must be separated from the seminal plasma by centrifuging, re-suspended in a phosphate buffer solution containing 5 per cent glucose and 30 per cent glycerol and cooled slowly to −79° C. About 25 per cent of the spermatozoa may then resume full motility on thawing, whereas few revive after rapid freezing. When guinea-pig spermatozoa are frozen rapidly in presence or absence of glycerol none revives. If, on the other hand, they are suspended in a glucose-saline solution buffered with phosphates and containing 15 per cent glycerol, and cooled slowly to −79° C., about 75 per cent resume active movement after thawing, although their acrosomes are severely distorted or absent. So far, definite morphological changes have not been seen in spermatozoa of any other species after cooling in the presence of glycerol. Rabbit spermatozoa differ from those of other species so far examined by their intolerance of glycerol in concentrations higher than 2.5 per cent in Ringer's solution or buffered saline and glucose-saline solutions at 20° C. If, however, rabbit semen is diluted with equal parts of either 10 per cent glycerol in distilled water, 20 per cent glycerol in 0.25 per cent gum arabic, or 30 per cent glycerol in 0.1 per cent methyl cellulose, the spermatozoa are highly active. Even in these diluents only 30 per cent are fully motile after slow cooling to −79° C. and subsequent warming to 40° C., and none survives rapid freezing. These results stress the importance of the rate at which the spermatozoa are cooled, and the composition of the medium in which they are suspended, for their revival from low temperatures. They do not support the view that rapid cooling to prevent crystal formation is the most important factor in their survival. In order to study changes in the medium and changes within the cell during cooling, a method has been devised for freezing material to very low temperatures under direct microscopical observation[6]. The results indicate that glycerol modifies the process of ice crystal formation and dissolution in the medium, so that damage due to pressure and other mechanical effects is reduced. Crystal formation within the spermatozoa is not seen, although, as shown by ultra-violet photomicrography, in the absence of glycerol their heads and midpieces are severely damaged by freezing.

It must be emphasized that the above results relate only to the motility of the spermatozoa after freezing. Satisfactory fertilizing power has so far not been demonstrated with any species. Glycerol-treated fowl semen has been inseminated into a large number of pullets. Out of more than two thousand eggs laid by birds inseminated with semen containing 5–20 per cent glycerol none has been fertile, whether the semen was frozen or not. This result indicates that the addition of glycerol alone caused loss of fertilizing power, whatever further effect freezing may have had. In later experiments it was found that 1 per cent is the maximum concentration of glycerol which unfrozen fowl semen will tolerate without losing fertilizing capacity, and in this concentration only an occasional spermatozoon survives freezing to −79° C Nevertheless, out of six hundred eggs laid by hens which had been inseminated with semen frozen in the presence of 1 or 2 per cent glycerol three chicks were hatched, and one embryo died between the fifth and eighteenth day of incubation It seems likely, therefore, that the very few spermatozoa which survive freezing under these conditions retain their fertilizing power The possibility is now under investigation that, as in the experiments of Shaffner[11], a considerable proportion of eggs were fertilized by frozen and thawed spermatozoa, but that the embryos died in the early stages of development Attempts have been made to reduce the concentration of glycerol required to protect fowl spermatozoa against low temperatures, or to prevent its adverse effects on fertilizing power, by incorporating other substances in the diluting fluids

Among the substances tried are lecithin, egg yolk, egg white, milk, glucose, fructose, mannose and other sugars, and different buffer substances and colloids So far, no diluent more effective and less harmful than glycerol in Ringer's solution has been found With propylene and ethylene glycol a concentration of 6 per cent in fowl semen permits normal fertility of unfrozen material, after freezing in this concentration, however, few spermatozoa are active, and the semen is infertile A concentration of 10–20 per cent of these substances severely reduces the fertility of unfrozen semen, so that after insemination only three fertile eggs were obtained out of four hundred laid by pullets Two live chicks and one dead embryo were obtained, however, from about the same number of eggs laid by hens inseminated with frozen semen

The mechanism by which these substances reduce the fertility of fowl semen is being studied With the semen of mammals reduced fertilizing power is often associated with low oxygen consumption[12] Preliminary metabolism studies indicate that glycerol reduces the oxygen consumption of fowl spermatozoa at 25° C. to a level which is not further reduced by subsequent freezing and thawing This adverse effect of glycerol on the fertilizing power of spermatozoa does not appear to be general. Rabbit semen diluted with 20 per cent glycerol in 0 25 per cent gum arabic, or 30 per cent glycerol in methyl cellulose, has been used for insemination and shows unimpaired fertilizing capacity; but so far only one fertile egg has been found among fifty-three recovered from the does inseminated with frozen semen The impaired fertility may be due, in the rabbit, to reduced motility of the semen when thawed As regards other species, there are special difficulties with other laboratory animals for work involving artificial insemination Experiments have been started with cattle, but progress is bound to be slow

A number of interesting problems are raised by this work First, the harmful effects of changes in the medium during freezing and thawing must be considered, and distinguished from those of changes in the cell itself Alterations in the medium might damage spermatozoa by mechanical effects such as pressure and tension during crystallization and thawing, or by physicochemical means such as altered tonicity during and after removal of water as ice Glycerol in the medium appeared to reduce mechanical damage, but whether it altered the physical and chemical state of the electrolytes and non-electrolytes after they had been concentrated by freezing, so as to reduce their harmful effects on the cells, is not clear Changes within the spermatozoa must be even more complicated, and probably vary from species to species Our microscopic studies of freezing amœbæ[6] support Luyet's view that a cell has little chance of surviving if free water crystallizes within it to form ice Spermatozoa may, however, have a low content of free water, and it seems that the risk of intracellular ice formation due to slow cooling is less important than the deleterious effects of rapid temperature changes which are known as temperature shock in the range above zero[12] and seem also to operate in some form in a range far below Secondly, the possibility that chemical and physical agents including temperature change have different effects on different parts or functions of the same cell must be borne in mind The action of glycerol on spermatozoa is obscure, and whether it influences the permeability of the cell membrane or whether it penetrates into the cell is not known. It is clear that in some species glycerol exerts a different effect on the midpiece and tail which are responsible for motility, and on the head which is directly concerned with fertilizing the ovum Thus, media containing glycerol in high concentrations support good motility of fowl spermatozoa but reduce their oxygen consumption and fertilizing capacity, whereas with rabbit spermatozoa glycerol reduces the motility but not the fertilizing power of the unfrozen semen The exact nature of these changes remains to be elucidated.

We are indebted to our colleague Dr D Herbert for carrying out the metabolism experiments on fowl spermatozoa.

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# PRODUCTION AND UTILIZATION OF CHEMICAL ENERGY

A DISCUSSION on "Chemical Energy" arranged by Section B (Chemistry) of the British Association was held at Birmingham on September 5 It was opened by two papers by Prof F H Garner, of the University of Birmingham, one of which served as an introduction to the general theme whereas the other dealt specifically with combustion reactions

Prof Garner, in his introductory talk, pointed out that the chemical energy liberated in a reaction may appear in several forms, notably as heat, light or electrical energy The main sources of chemical energy are those which have been derived originally from the radiant energy of the sun and are stored in natural fossil fuels such as coal, petroleum, shale or peat These are capital resources and, moreover, wasting assets the energy of which is made available by combustion processes, the liberated heat being used as such or converted into mechanical or electrical energy The transformation of heat into mechanical energy is a process of strictly limited efficiency because of the operation of the Second Law of Thermodynamics, and all heat engines have relatively low efficiencies, usually less than 40 per cent

Prof Garner stressed, however, the importance of energy being produced in a convenient form, for this factor is often of greater importance than that of thermal efficiency, and the factor of cost inevitably enters into considerations of energy utilization

Most of the efficiencies attained in the utilization of chemical energy are extremely low, for the production of industrial power and heat from coal, the average overall efficiency has been calculated to be 17 per cent Thus, although steam may be generated at thermal efficiencies of 85 per cent, the conversion to mechanical energy at an efficiency of 35 per cent gives a combined efficiency of only 30 per cent The conversion of mechanical energy to electrical energy is, however, an efficient process, and consequently the overall efficiency of electricity generation can be as high as 29 per cent Where heat energy is used at high temperatures, for example, in metallurgical and glass furnaces, efficiencies attained are low since the waste gases are discharged at high temperatures By employing these hot waste gases for steam generation or for pre-heating the air to be used for combustion of the fuel, or in other ways, much can be done to raise efficiencies

Liquid fuels are preferred for transport by sea, land and air, due largely to convenience in handling, and ease of flow and control in the power unit itself

In his second paper, Prof Garner considered the efficiency in use of the chemical energy from combustion, in heating processes and in its conversion to mechanical and electrical energy

The use of fuels in their natural state leads to high thermal efficiencies only in a few applications, one of the chief of which is steam raising, where thermal efficiencies of 90 per cent are obtainable in efficient power stations, although only where the steam can be used efficiently can a high overall figure be attained

In the field of transportation, there are three forms of internal combustion engine the spark-ignition (petrol) engine, the compression-ignition (diesel) engine, and the gas turbine The efficiency of spark- and compression-ignition engines depends upon the compression ratio employed Ricardo showed that unless suitable fuels are supplied for a given value of the compression ratio, 'knocking' occurs with its attendant tendency to pre-ignition, loss in efficiency and possible damage to the engine In order to enable high compression ratios to be used, aromatics were introduced as the first anti-knock agents, but later, processes for cracking petroleum were developed Cracked gases are now largely converted by processes of polymerization, alkylation and isomerization to synthetic hydrocarbons which have made possible the modern high-octane aviation fuels still further improved by the addition of lead tetraethyl

The diesel engine is thermally more efficient than the petrol engine and is finding increasing use in the larger-size units, as in rail and sea transport

The thermal efficiency of the motor-car engine is only about 6 per cent in the United States, owing to the higher cost of fuel in Great Britain, smaller and more efficient engines have been developed The figure is low, since most of the time the engine is ducing power equivalent to less than one-quarter load The aircraft engine which operates mainly at full load reaches an efficiency of 12 per cent

Prof Garner drew an interesting comparison between the coal-fired steam and the oil-fired locomotive and the diesel-electric locomotive, with thermal efficiencies of 4, 6 and 26 per cent respectively, and pointed out that in the United States this is leading to a rapid replacement of the steam locomotive by the diesel-electric engine for railway purposes

In conclusion, Prof Garner dealt with the gas turbine, which for aviation purposes employs kerosene as fuel The gas turbine does not demand a fuel of high octane or cetane number, but fuels other than clean distillate fuels may lead to deposits on, or erosion of, the turbine blades In particular, petroleum residual oils of low ash content have led to serious deposits, apparently due to the minute contents of vanadium of the order of 0 04 per cent or less The future of the larger-sized gas turbines, for which efficiencies of more than 30 per cent are expected, appears to depend on the extent to which the natural fuels, coal and petroleum, can be used

Dr James Taylor (Nobel Division, I C I, Ltd) pointed out that there is another important class of chemical reaction which man has harnessed to replace human effort These diverse exothermic reactions are not economic methods of providing energy except for providing high power for very short intervals of time, or for use under conditions where atmospheric oxygen is not available Many of these reactions are very violent, as, for example, in high explosives, whereas in other cases the rate depends upon the pressure of operation, and the materials, for example, cordite, can be used as propellants

The important property of explosives is that they are self-propagating when initiated or ignited from a local point In the case of high explosives, 'point' initiation is normally provided by a local intense shock or blow as from a detonator, which comprises a small metal tube filled with an explosive such as fulminate of mercury Initiation in the case of propellants, such as cordite or incendiary mixtures, is usually thermal in character, generally by means of a flame

Dr Taylor traced the development of explosives from gunpowder to the detonating explosives in which reaction is initiated and sustained by a mechanical shock wave passing at high velocity through the explosive Such explosives are of vital importance in civil and mining engineering For mining purposes, gunpowder cannot be used safely where methane/air mixtures are liable to occur The position has been completely altered by the advent of detonating explosives, and by the incorporation of cooling materials like common salt into explosives based on nitroglycerine (or T N T) and ammonium nitrate, the so-called 'permitted' explosives have been developed In rockets, black powder has been displaced by cordite, and these are now used for the assisted take-off of aircraft, recently increasing attention has been given to the use of propellants as controlled energy sources for performing mechanical operations The power cartridge field includes cartridges for starting aero engines, for the ejection of pilots from high-speed aircraft in an emergency and for a variety of other purposes

Gentler types of mixture were also discussed, and reference was made to a cartridge developed for insertion into tinned soup for providing hot refreshment for troops during the War Another mixture of antimony and potassium permanganate has been used in making delay fuses for detonators, and these can be used for controlled blasting

The decomposition of ammonium nitrate is extremely complex and does not occur readily in normal circumstances, however, certain substances such as potassium chromate or ammonium dichromate, added in quantities of the order of a few per cent, cause the self-sustained decomposition of this substance Such compositions can be pressed into compact cylinders and will provide gas steadily for long periods They can be used for driving motors or as fuels for rockets and jet-propelled devices Guanidine nitrate compositions have been used for operating jet propulsion units for model aeroplanes and motor-cars

Liquid mono-propellants such as concentrated (80–85 per cent) hydrogen peroxide, methyl and ethyl nitrates, nitromethane and other substances were discussed, and the use of the first in the launching device for the German *V*1 weapon was mentioned Bi-propellants such as liquid oxygen and alcohols, or concentrated nitric acid and aniline, have been used in rockets of the *V*2 type

Dr Taylor illustrated his lecture by means of a series of carefully executed and spectacular demonstrations which proved to be exceedingly popular with his audience

The third speaker, Dr H J T Ellingham (Royal Institute of Chemistry), discussed the direct conversion of chemical energy to electrical energy He pointed out that a voltaic cell may be regarded as a device for converting the 'free energy' of a reaction into electrical energy In principle, almost any type of spontaneously occurring chemical reaction is capable of being harnessed in a voltaic cell In practice, however, few types of reaction have been effectively used in this way, and the operation of practically all established forms of primary cell is based on the oxidation of a metal (generally zinc) to one or other of its compounds If an efficient cell could be developed to harness the oxidation of carbon, it might provide an alternative means for the large-scale generation of electrical energy from coal The possibility is attractive, because no upper limit of efficiency is set by the Second Law of Thermodynamics as in the heat-engine stage of the existing process Even if it proved impracticable to make use of the direct oxidation of coal or coke, there might still be scope for an indirect fuel cell operating on the oxidation of secondary fuels such as hydrogen or carbon monoxide

Possible reactions were discussed in some detail and it was suggested that metals such as tin or lead, which can be obtained by carbon reduction at relatively low temperatures, would be preferable for use in cells to higher-melting metals or those with much greater affinity for oxygen

The general form of a fuel cell is

$$\begin{array}{c|c|c} \text{fuel} & \text{electrolyte} & \text{oxygen} \\ - & & + \end{array}$$

The oxygen would preferably be supplied as air to avoid the cost of separation During the discharge of such a cell, oxygen ionizes at the positive electrode giving oxygen or oxygenated ions (hydroxyl ions in aqueous solution), while at the negative electrode *either* the fuel substance ionizes (hydrogen or the metals yielding positive ions) *or* the oxygen or oxygenated ions in the electrolyte are discharged, forming nascent oxygen which then reacts at the anode surface with the fuel substance

Neither carbon nor carbon monoxide can furnish corresponding ions, and their use in a fuel cell depends on their being oxidized anodically by nascent oxygen —a reaction which only proceeds at a reasonable rate at an elevated temperature Oxygen does not give a reversible electrode system as does hydrogen adsorbed on the surface of platinum, however, oxygen diffusion electrodes have been developed, and temperatures of more than 200° C have been used for hydrogen – oxygen cells in aqueous solution working at pressures up to 55 atmospheres The fact that raising the temperature increases rates of reaction and diffusion makes the prospects of fuel cells with molten-salt electrolytes seem attractive

Dr Ellingham reviewed experimental work upon molten-salt electrolyte fuel cells and suggested that they might be designed to convert more than 30 per cent of the chemical energy to electrical energy

In conclusion, it was suggested that more attention might be given to the possibility of linking cell reactions consuming secondary fuels with the process of production of the fuel from carbon, in which manner improved heat economy might be attained

Prof F G Gregory (Imperial College of Science and Technology, London), who concluded the discussion, considered the building up of chemical energy by vegetation, and discussed estimates which have been made of the material turnover in the carbon cycle in terms of the amount of carbon fixed per annum from the atmosphere and oceans

The amount of solar radiation reaching the earth's surface can be estimated, and an approximate value obtained for the amount of suitable radiation available for photosynthesis From these results it is possible to deduce a rough value for the efficiency of utilization of solar energy by vegetation, and this is found to be of the order of 1 per cent The factors controlling photosynthesis were discussed and figures given to show that plants very dissimilar in nature assimilate at the same rate under the same conditions

A thirty-fold increase in concentration of carbon dioxide only results in a four-fold assimilation, and although an increase in temperature results in an increase in assimilation-rate up to 25° C, this appears to be the optimum temperature Experiments have shown that total assimilation varies little with the latitude at which the vegetation grows

Experiments were described with a number of plants such as barley, cotton, mangold and sugar beet, in which the net assimilation-rate in terms of dry-matter increase per unit leaf area per unit time was determined The results show that for these plants growing in very different environments and at different levels of nutrition, the net assimilation-rate varies only within narrow limits

By burning the dry material in a bomb calorimeter, the energy content can be found, and by recording the varying intensity of radiation which has fallen on the plants over a period and knowing the mean leaf area, the efficiency of energy storage can be determined This is of a low order, never exceeding 1 5 per cent for varying levels of manuring It appears, therefore, that neither by varying the plant nor the fertility of the soil can the efficiency of energy accumulation be greatly changed, although the total quantity of dry matter can be increased if the total leaf surface is increased by more rapid development of the plants

There appears to be little hope that the efficiency of the photosynthetic process can be increased by selection or breeding.

On the basis of this information, Prof. Gregory considered the most effective methods of utilizing plant growth for storing solar energy. The most convenient product would be sugar or starch in the form of stored products in tubers or roots, which would be readily convertible to alcohol by fermentation processes. Prof. Gregory mentioned schemes which have been suggested for using micro-organisms, such as the green alga *Chlorella*, for the building up of chemical energy, and pointed out that there are so many difficulties that the use of higher plants with storage organs would appear more economical.

R. LONG

# FUNCTIONS OF THE SKIN OF VERTEBRATES

SECTIONS D (Zoology) and I (Physiology) of the British Association joined forces on the morning of September 1 to hear a group of papers on the functions of the skin.

Prof. P. B. Medawar (Birmingham) opened the session by discussing the anatomy of the mammalian epidermis, referring specially to the anatomical basis of pigmentary activity. He said that standard textbook diagrams of transverse sections of the skin are almost invariably at fault in their complete omission of the cells responsible for melanin formation—the cells variously called dendritic cells or epidermal melanoblasts or melanophores. Dendritic cells form a distinct lineage in the epidermis, and, as American work has shown, arise in development from the neural crest. The dendritic cell is the sole origin and seat of pigmentary function in the epidermis. In some manner the melanin formed within it is caused to enter into the cytoplasm of the Malpighian cells on which its branches end, a peculiar mode of secretion which Masson has called 'cytocrine'. Studies of whole mounts of pure epidermal sheets, treated with Methylene Blue or the Dopa reagent, reveal the shape, number and distribution of dendritic cells with conspicuous clarity. In particular, they reveal that dendritic cells, which are so distributed in the basal layer as to lie at arms' length from each other, often anastomose to form local syncytia.

Prof. Medawar recalled R. E. Billingham's demonstration that white and negro skins resemble each other in the number, form and distribution of their dendritic cells. The difference between them is merely functional: the dendritic cell of negro skin maintains the higher level of pigmentary activity. The same is true of the difference between red and black skin areas in patched guinea pigs.

In conclusion, Prof. Medawar asked for a revision of text-book diagrams of the anatomy of the epidermis, and said that British dermatologists might well revise, or at least reconsider, the histopathology of skin in the light of this newer knowledge of its anatomy.

Dr. J. D. Findlay and Mr. W. R. Beakley (Hannah Dairy Research Institute, Ayr) reported work which throws quite a new light on the problem of temperature regulation in cattle. Dr. Findlay put the question whether cows sweat—indeed, whether they have sweat glands at all. Deep in the dermis of cows' skin lie large, poorly vascularized, sac-like glands lined o-epithelial cells which pass a colloid secretion through ducts on to the skin surface[1]. These are commonly called sweat glands, but there is no evidence that they are instruments of temperature control.

The climatological room at the Hannah Institute was described by Dr. Findlay. The room was designed to study the mode of heat loss in cattle. It can be kept at any temperature between 20° and 60° C., and at almost any humidity, with or without air movement; and suitable instrumentation makes it possible to keep a continuous record of the respiration-rate, heart-rate and skin-temperature of the calves kept in it. It has been shown that, at a constant saturation deficit, the skin-temperature rises in direct proportion to the temperature of the environment: there is no flattening or drop at any level to suggest that sweating has begun. Peripheral vasodilatation in calf skin is probably already at maximum at 20°. Moreover, injections of pilocarpine or adrenaline, which provoke sweating in horses, have no such effect on calves.

Presumably, then, said Dr. Findlay, the cow loses heat from the skin primarily by radiation—unlike the horse, but probably like the dog and sheep. The cow is therefore not well adapted to tropical climates; but, as Bonsma has shown, the cow best adapted as a radiator of heat is one with a glossy coat of light colour bearing short hairs with pigmented tips. It is noteworthy that tropical cattle like the zebu have the same skin structure as those from more temperate climates. One reason for their superior heat tolerance is probably the very large dewlap which, since it has a particularly dense network of capillaries immediately below the skin surface, is probably an efficient extra radiator of heat.

Dr. W. S. Bullough (Sheffield) described his work on the replacement of the epidermis. Just as hairs might be replaced continuously, as in sheep, periodically, as in rats and mice, or seasonally, as in wild mammals, so the replacement of the epidermal layer is not a continuous and uniform process. There are recognizable patterns of replacement in space (for example, the anterior-posterior gradient of cell-division frequency in the skin of the mouse's back) and rhythms of replacement in time. All mice show a daily rhythm, and in female mice a rhythm in step with the œstrous cycle is superimposed on it.

Mitotic activity is high during natural or artificially induced sleep or at rest, and muscular activity is probably responsible for its fall by day. Injections of glucose or of phosphate before sleep raise the rate of cell division, and injections of phlorizin lower it. The blood-sugar level falls during rest, but significant quantities of glycogen are deposited in the skin as well as in the liver, and the rate of cell division at once rises. The facts, said Dr. Bullough, suggest that glycogen is the energy source that controls rate of cell division. It is noteworthy that although skin cultured *in vitro* in the absence of oxygen shows no new cell divisions, those started pass to completion. Oxygen, glycogen and phosphate all seem to act in advance of visible prophase—perhaps in an 'antephase' as little as fifteen minutes beforehand.

The general rise of mitotic activity during œstrus in female mice is no less conspicuous in the epidermis than elsewhere. Dr. Bullough suggested that œstrogen acts both directly, in influencing the frequency and completion-time of mitosis, and, indirectly, by mobilizing glycogen and causing its deposition in the epidermis, and by dilating the capillaries and perhaps increasing their permeability. The abundance of œstrogen in plants hints at the possibility that it exerts a very widespread action as a controller of mitosis

Dr Bullough ended by saying that a study of mitotic frequency has obvious practical bearings Lowering the food intake of mice by one-third depresses the rate of cell division, and is known to prolong their life, lower the frequency of tumour incidence and to discourage the multiplication of parasites

Dr J S Weiner (Oxford) dealt with the activity of sweat glands in man He pointed out that an accurate census of sweat glands over the skin surface has still to be made, and that the degree of variation between individuals and races is unknown We are largely ignorant even of the functional morphology of the individual gland What, for example, is the blood supply of the duct of the gland, and what is the energy source of sweating ? Work at Oxford has begun with an investigation of technique In Japan, Kuno has shown it to be possible to cannulate the ducts of single glands, and it has now proved possible to dissect out individual glands for study in the microrespirometer Sweat itself can be collected in an arm bag or by washing down the body surface with water By this second technique, which has now been adapted for serial sampling, the production of sweat can only be computed indirectly from the change of body-weight Arm sweat has proved to be more concentrated than body sweat, though the proportions of solutes in the two are the same About 95 per cent of the osmotic activity of sweat can be accounted for approximately 80 per cent is due to chloride, 10–11 per cent to lactate, and 2–3 per cent to urea

Preliminary studies have shown that although sweat glands are subject to fatigue, the rate of sweating increases with time of exposure to high temperatures, its chloride concentration is related to the skin temperature Acclimatization brings about increased sweating, and this is largely responsible for the increasing dilution of the sweat in the arm bag

A clue to the source of energy for sweating is given by the fact that the lactate content rises in sweat from an arm rendered ischæmic by an arterial cuff The chloride content drops in the earlier stages of ischæmia

Prof A M Boyd (Manchester) spoke of the treatment of excessive sweating by sympathectomy The area of sweating can be mapped by painting the patient with a suitable indicator powder, but this is a messy method and its use makes it necessary to warm the patient up It has been found possible to map the area of sweating by recording changes in the electrical resistance of the skin The resistance of dry skin is only 10 per cent higher than that of damp skin; but the method now in use in Prof Boyd's laboratory is sensitive enough to record it without warming the patient up

Hyperhydrosis—excessive sweating—particularly of the extremities, can have serious consequences, fungal infection and the allergic dermatitis and ulceration associated with it can be so severe as to simulate gangrene Sympathectomy can abolish hyperhydrosis over the area of denervation, and is, of course, used for the treatment of other disabilities as well—in the relief of arterial block, for example, to ensure the establishment of a good collateral circulation To abolish hyperhydrosis of the legs and feet, a sympathectomy involving the second and third lumbar ganglia is not always satisfactory, for the area of denervation may sometimes be confined to as small an area as the inner aspect of the calves The best result is to be achieved by sympathectomy involving the first lumbar ganglion as well, and Prof Boyd dismissed as an illusion the idea that this operation affects the fertility of the male

Among the matters that arose in discussion at the end of the morning's session were the unsatisfactory state of our clinical knowledge of leucoderma (local skin depigmentation) Prof Medawar said that leucoderma may be due to a local destruction of pigment-forming cells or to a temporary suppression of their pigmentary activity, the latter is probably the explanation of the depigmentation caused by, for example, industrial anti-oxidants In answer to a question on the distribution of mitoses in the epidermis, Dr Bullough said that in his experience mitosis in normal skin is confined to the basal layer, that is, the epidermal cells at the dermo-epidermal interface Mitosis may occur at a slightly more superficial level in hyperplastic skin

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[1] Findlay and Yang, *J Agr Sci* (in the press)

## OBITUARY

### Mr R Winckworth

RONALD WINCKWORTH, who died at his home at South Norwood on September 6, in his sixty-sixth year, was one of the best known British malacologists He was educated at Epsom College (1896–1902) and at Jesus College, Oxford, where he read mathematics (1906–10) After leaving the University, he held a number of scholastic appointments and was teacher of mathematics at Brighton Technical College (1912–14) On the outbreak of war, Winckworth enlisted as a seaman, and later became paymaster-lieutenant He served in several of H M ships and saw service in northern European waters and at Gibraltar

After the First World War, Winckworth's love of natural history led him to accept a post as assistant at the Marine Biological Laboratory, Plymouth, and it was here that he laid the foundation for his later work on Mollusca He left Plymouth in 1921 and, after some miscellaneous teaching and lecturing, spent six months studying natural history in India and Ceylon

In October 1925, he joined the administrative staff of the Royal Society and worked at first on publications and later as librarian He became assistant secretary in 1932 and assistant editor from 1937 until his retirement, due to ill health, in 1944

From 1925 Winckworth devoted much of his leisure hours to the study of British and Indian Ocean Mollusca and published many papers, mainly in the *Journal of Conchology* and in the *Proceedings of the Malacological Society* He never missed opportunities of collecting in the field, but his official duties precluded much work on the living animal, and he became one of our foremost authorities on the systematics and bibliography of the Mollusca His "British Marine Mollusca" (*J Conch*, 19, 1932) will be long remembered as a successful attempt to stabilize the names of our molluscs In collaboration with his brother (the late Col H C Winckworth) he began a long-term project to study Indian Ocean Mollusca, particularly the nudibranchs This was not completed, due to his brother's death and his own ill health

Winckworth was enthusiastic and energetic in all that he undertook and was always ready to help students of Mollusca, all were hospitably received at his house at South Norwood As editor of the *Proceedings of the Malacological Society* (1928–47), he gave many a beginner valuable aid and encouragement in writing a first paper, and the more experienced could always obtain sound advice on their problems He was a simple and generous man, neat and methodical in his ways, and had a passion for orderliness in all things His particular niche in British malacology will not easily be filled and his death will be felt as a personal loss by friends in many lands

Winckworth belonged to many scientific societies and held office in several, including the Linnean Society of London (council 1943–47, vice-president 1945–47), the Malacological Society of London (council 1924–48, president 1939–42, elected honorary member 1949), the Conchological Society (president 1930–31) He was also a founder member of the Society for the Bibliography of Natural History and of the Systematics Association

He first married Margaret Wallace, who died in 1939, and later Alison Mary Cruickshank, who nursed him with great devotion through a long illness

W J REES

# NEWS and VIEWS

## Radcliffe Observatory, Pretoria

### Dr H Knox-Shaw

DR HAROLD KNOX-SHAW has retired from the post of Radcliffe Observer and director of the Radcliffe Observatory, Pretoria A pupil of S A Saunder at Wellington College and of A R Hinks at the Cambridge Observatory, he left Trinity College, Cambridge, in 1908 to become astronomical observer and afterwards director of the Khedivial Observatory, Helwan, Egypt There his chief work lay in the photography of nebulæ and comets with the 30-in Reynolds reflector. He secured the first photograph of Halley's comet at its return in 1910 In 1924 he succeeded Rambaut as Radcliffe Observer at Oxford, carrying on such work as measures of stellar parallaxes, and of Kapteyn's selected areas The decision of the Radcliffe Trustees to sell the Oxford site to Lord Nuffield, to meet the growing needs of the Radcliffe Infirmary, was coupled with a plan to build a new 74-in reflecting telescope in the southern hemisphere on a suitable site While carrying on work on the reduction of stellar observations, including a long early series by Hornsby, Dr Knox-Shaw's activities centred more and more from 1934 onwards on the erection of the new observatory buildings near Pretoria and of the telescope itself A series of delays due to legal proceedings, difficulties in casting the mirror and the War prevented the arrival of the mirror in Pretoria until 1948, while even now the spectrograph for use at the Cassegrain focus, ordered and put in hand before the War began, has not been delivered Much sympathy has been felt in astronomical circles with Dr Knox-Shaw for the years of frustration that he passed through, but at least he has had the joy of seeing a first-class 74-in mirror successfully at work in the telescope, and of knowing that a tremendously rich field of opportunity has opened up for the future Dr Knox-Shaw was president of the Royal Astronomical Society during 1931–33

### Dr. A. D. Thackeray

DR A D THACKERAY, who succeeds Dr. Knox-Shaw as Radcliffe Observer, was educated at Eton and King's College, Cambridge He was elected to the Sheepshanks Exhibition at Cambridge to work at the Solar Physics Observatory and later to a Commonwealth Fund Fellowship, with which he worked for two years at Mt Wilson Observatory He returned to Cambridge as assistant director of the Solar Physics Observatory, acting as director for a time arly years of the War In 1947 he became sistant at the Radcliffe Observatory His work has been principally observational, covering a wide range of problems on stellar spectra, contours of absorption lines and on nebulæ He has taken part in eclipse expeditions in Canada (1932) and Japan (1936) He has now a great opportunity of organising a wide programme of research in a very open field happily, there is good prospect that his small staff will be supplemented by observers from other countries, who will make of the Radcliffe Observatory an important international centre of research

## Carty Medal and Award of the U.S. National Academy of Sciences: Dr Irving Langmuir

THE John J Carty Gold Medal and Award of the U S National Academy of Sciences has been awarded to Dr Irving Langmuir, who recently retired from the post of associate director of the General Electric Research Laboratory, Schenectady, New York This Medal was established in 1930 in honour of the late John J Carty, a member of the Academy, by his close associates, as a token of esteem on the occasion of his retirement from the vice-presidency of the American Telephone and Telegraph Co It is awarded not more than once in two years and is given for noteworthy contributions to the advancement of fundamental or applied science in any field Dr Langmuir has received many high honours, among which may be mentioned the Nobel Prize in Chemistry (1932), his election as a foreign member of the Royal Society (1935), the Faraday Medal of the Chemical Society (1938), and the Faraday Medal of the Institution of Electrical Engineers (1944) His research work is remarkable for the extraordinarily wide range of his investigations These include electric lighting, electron emission and gaseous discharge, surface chemistry and (during the Second World War) the production of smoke screens Besides his interests in many branches of pure and applied science, Dr Langmuir has made a number of valuable contributions to general scientific thought and the philosophy of science

## Geology at the Aligarh University

A DEPARTMENT of Geology has been created at Aligarh University and Dr P N Ganju has been appointed reader and chairman of the new Department Dr Ganju has recently returned from King's College, University of Durham, where he specialized in coal petrology The importance of trained geologists in India needs no emphasis, a great deal remains to be done in developing and exploring the mineral resources of this vast country. At the moment, very few Indian universities have well-equipped geological laboratories and perhaps none is equipped for research in coal petrology Dr Ganju's appointment will help to initiate this work in this new field so necessary in the investigation of the coals and coal-fields of India

### College of Aeronautics, Bletchley

### Prof. W S. Hemp

A CHAIR in aircraft structures and aero-elasticity in the Department of Aircraft Design of the College of Aeronautics, Bletchley, has recently been established, and Mr W S Hemp, formerly senior lecturer in aircraft structures and the deputy head of the Department, has been appointed as the first holder Prof Hemp, who is a graduate in mathematics of the University of Cambridge, joined the staff of the College in September 1946 During 1938–46 he was engaged on design and research work, mainly on structures, at the Bristol Aeroplane Co , Ltd , and during 1944–45, while in charge of the Project Stress Office, he carried out the preliminary structural and dynamical investigations on the *Brabazon* air-liner He is the author of numerous research reports and a small monograph on stressed skin construction

### International Union of Biological Sciences

THE tenth triennial General Assembly of the International Union of Biological Sciences was held at Stockholm during July 7–11, presided over by Prof M J Sirks (Netherlands), sixty-seven delegates from nineteen countries being present The Union is one of a number of Unions representing different sciences under the ægis of the International Council of Scientific Unions It comprises Sections of Biometry, Botany, Embryology, Entomology, Experimental Cytology, Genetics, Limnology, Microbiology and Zoology It possesses limited funds derived from payments by adhering countries, and also acts in an advisory capacity to Unesco for the expenditure of money by the latter body on biological projects Financial support has been given to nineteen type-culture collections of micro-organisms and *Drosophila* in various countries, to certain abstracting periodicals, to the preparation of directories of botanists, geneticists and zoologists, to the preparation of a list of the location of zoological type specimens, to international congresses and more particularly specialist symposia, to international commissions on zoological and botanical nomenclature, to the Zoological Station of Naples, to the International Depot of Cytological Preparations at Louvain, etc A Commission of the Union is concerned with the biological control of pests, and there is a Joint Commission with certain other Unions on oceanography At the close of the General Assembly the following officers were elected *President,* Prof H Munro Fox (Great Britain) , *Vice-President,* Prof J Runnstrom (Sweden) , *Secretary-General,* Prof P Vayssière (France) , *Secretary,* Prof Stuart Mudd (United States) , *Treasurer,* Prof F Chodat (Switzerland)

### Rhodesian Agricultural College

THE opening of the Rhodesian Agricultural College at Gwebi by the prime minister of Southern Rhodesia, Sir Godfrey Huggins, on February 15, is a landmark in the country's farming history and will, it is hoped, prove a first step towards the creation of a Rhodesian university. The administration of the College is in the hands of an advisory committee, composed of prominent members of the farming and business world, and Dr W L Fielding, formerly of the Cotton Research Station at Barberton, has been appointed the first principal The farm covers 3,800 acres and contains a considerable arable area as well as extensive livestock paddocks It originally formed part of the Government Experimental Farm and is already largely mechanized Many buildings are in consequence available; but a hostel, lecture hall and staff houses have recently been built New workshops are planned and the main college building will be also added later A start has been made with twenty-four students and a staff of four Officers of the Department of Agriculture and Lands will assist with lectures on special subjects, and instructors acting under a superintendent are to be in charge of the practical work A general standard of education equivalent to that of the Cambridge School Certificate will be expected on entry, and the students will study a diploma course designed to cover two years Emphasis will be laid on the practical aspects of farming, and sons of farmers will be specially encouraged to enter the College

### Scraper Tools in Prehistory

MANY years ago an author of a small book on prehistory described a scraper as "any odd bit of flint for which the prehistorian could not find a better name" Such a definition is no longer possible, and those who used to think it so should read Mr A. D Lacaille's exhaustive study, "The Scraper in Prehistory" (*Trans Glasgow Archæological Soc* , 11 , 1947) Obviously at all periods scraping tools were needed for many purposes—fashioning bones or wood, preparing skins, etc —and, equally obviously, a variety of different forms would be required The author passes these matters under review throughout prehistoric times There is a large number of illustrations

### Organising for Output

IN order to help the man on the shop floor to understand some of the problems of production management, the British Institute of Management has prepared a booklet describing the technical side of a works manager's job ("Organising for Output" , 2*s* 6*d* ) It does not pretend to teach men how to become managers but tries to show how the production side of a works is organised, the job that each member of the management staff is doing, and its effect on the productivity of the worker and the factory Since so much has already been written about them, discussion of the work of joint production committees, works committees, and of the welfare department has been deliberately omitted Among the topics discussed are managerial problems, the cost of the product, works organisation, production planning, storekeeping and stock control, work measurement and methods, engineering, shop and factory layout, work study and the worker's method, inspection, maintenance and incentives A useful appendix describes the American labour unions' production engineering departments, and the booklet also contains a discriminately selected bibliography.

### Indian Earthquake Observations

THE observatories of the India Meteorological Department, under the direction of Dr S K Banerji, have seismological installations at Bombay, Calcutta, Kodaikanal, New Delhi and Poona, equipped with Milne-Shaw, Omori-Ewing and Wood-Anderson instruments Seismic data thus obtained, together with the instrumental data from Colombo, Dehra Dun and Hyderabad Observatories, thanks to the co-operation of the Directors of these Observatories, are collected and edited at the Meteorological Office, Poona At Poona also are collected and edited the non-instrumental earthquake data reported from time to time From January 1948 a monthly seismological bulletin has been issued, and the latest to be received is for December 1949 The greatest numbers of earthquakes felt by observers during December 1949 were three at Darjeeling and three at Tezpur, all having an intensity 5 on the Rossi–Forel scale

### Illuminating Engineering Society

Mr L J Davies, director of the Research Laboratory of the British Thomson-Houston Company, Ltd , has been elected president for 1950–51 of the Illuminating Engineering Society The Leon Gaster Memorial Premium (of 10 guineas), which is for the best contribution published by the Society during the year, has been awarded to Dr R G Hopkinson and Mr. P Petherbridge (both of the Building Research Station, Garston, near Watford), for their paper entitled "Discomfort Glare in Relation to the Lighting of Buildings" The Silver Jubilee Commemoration Award (of 5 guineas) has been given to Mr I H Hall, of Birmingham, for an essay entitled "Some Problems Associated with the Development of the Fluorescent Lamp" This is the first occasion on which this has been awarded for several years , it is open only to members of the Society under the age of twenty-five years for a paper on some aspect of illuminating engineering

### Public Works and Municipal Services Congress and Exhibition

The Public Works and Municipal Services Congress and Exhibition for 1950 will be held in the Olympia, London, W 14, during November 13–18 The opening ceremony will be performed by Mr Aneurin Bevan, Minister of Health and president of the Congress and Exhibition Council A number of conferences, each one under the auspices of a particular organisation, have been arranged in connexion with the Congress, and these organisations are the Association of Public Lighting Engineers, Institution of Municipal Engineers, Institution of Gas Engineers, County Surveyors Society, County Land Agents Association, Institution of Civil Engineers, Institute of Park Administration (Inc ), British Waterworks Association, Town Planning Institute, Institute of Sewage Purification, Institute of Public Cleansing and the Royal Institute of British Architects Further details can be obtained from the secretary of the Public Works and Municipal Services Congress, 84 Eccleston Square, London, S W 1

### Announcements

Prof André Mayer, professor of natural history in the Collège de France, has been elected member of the Section of Rural Economy and Veterinary Practice of the Paris Academy of Sciences, in succession to the late Prof R Fosse

Mr A P C Cumming has been elected to a Salters' Fellowship for research in chemical engineering during the year 1950–51

G H Noordhof has been appointed a lecturer Department of Education of the International Wool Secretariat Mr Noordhof is a graduate of the Universities of Cambridge and London, and has carried out research for the Department of Scientific and Industrial Research in the field of physical chemistry

The following appointments in the National Agricultural Advisory Service of Britain have recently been announced Mr H L Shrimpton, deputy chief livestock husbandry officer, to be chief livestock husbandry officer in the Service in succession to Mr H Twinch, who has retired , Mr H Trefor Jones, provincial soils chemist in the Yorkshire and Lancashire Province of the Service, to be deputy provincial director for the Yorkshire and Lancashire Province in succession to Mr W Weir, who has retired

The British Standards Institution has opened a branch office at 12 Hilton Street, Manchester, 1, in charge of Mr A F B Nall, an assistant technical director of the Institution (telephone Central 4856; telegrams Bristandin, Manchester) At this office a complete set of British Standards, some 1,600 in number, may be consulted and copies purchased

The fifth of the series of Oxford Management Conferences, under the auspices of the British Institute of Management (Management House, 8 Hill Street, London, W 1), will be held at Harrogate during November 16–19 Sectional meetings will be divided into two types panel debate, in which broad issues will be considered, without advance circulation of the papers , and discussion sessions, in which specific issues will be discussed in considerable detail, with the idea of reaching definite conclusions, and in which the papers will be circulated in advance

The Royal Society of New Zealand is offering the T K Sidey Summer-Time Award, consisting of a bronze medal and a prize of £100 (N Z currency) This award is to be made primarily (though not necessarily) to a New Zealand citizen, or scientific worker in New Zealand for research on light visible and invisible and other solar radiations in relation to human welfare, or on electromagnetic radiations of every kind Further information can be obtained from the secretary of the Royal Society of New Zealand, Victoria University College, Wellington, New Zealand

The Sintered Oxides Sub-Committee of the Inter-Service Metallurgical Research Council (Ministry of Supply and Admiralty) has recently, in consultation with manufacturers, standardized the production of tubes of special refractory to two materials—impervious alumina and impervious mullite (for use up to 1,700° C )—with eight sizes in the range of internal diameters 5–75 mm and corresponding wall thicknesses of 1 5–5 5 mm All standard tubes will be available in lengths up to 900 mm with both ends open, or one open and the other hemispherically closed At the same time a standard cross-section of impervious alumina twin-bore thermocouple insulator has been agreed upon

Erratum In the communication "Runs Up and Down on a Lattice" by Prof P V Krishna Iyer in *Nature* of August 12, p 276, for "Variance for (1) and (2) " read

$$\left.\begin{matrix}\text{“Variance for}\\ \text{(1) and (2)}\end{matrix}\right\} = \frac{1}{90}\left\{16n(1^n) - 29(1^{n-1})\right\},$$

where $(1^r)$ denotes the monomial symmetric function of degree $r$ in $l_1$, $l_2$, $l_n$"

# STATE OF HÆMOGLOBIN IN SICKLE-CELL ANÆMIA

By
DR. M. F. PERUTZ
Cavendish Laboratory and Molteno Institute,
AND
J. M. MITCHISON
Department of Zoology,
University of Cambridge

SICKLE-CELL anæmia is a congenital disease found among Negroes. It manifests itself in a reversible change in shape which the red cells undergo in response to changes in the partial pressure of oxygen, and which appears to lead to an excessive rate of red-cell destruction. In arterial blood these cells have the shape of normal biconcave disks, while in venous blood between 30 and 60 per cent of the cells assume the shape of sickles, holly wreaths or straight tubes. These reversible changes have been reproduced *in vitro* and described in detail, for example by Ponder[1]. Pauling *et al.*[2] showed that the hæmoglobin from sickle-cell anæmia patients has a different electrophoretic mobility from normal human hæmoglobin. They suggested that the disease may be caused by a change in the composition or structure of the hæmoglobin molecule, leading to molecular aggregation of hæmoglobin in the de-oxygenated state. However, more recently Pauling *et al.*[3] reported that no significant differences between the acidic and basic amino-acid contents of the two proteins could be found, and that the hæms were identical. Even more surprising was the observation that the differences in electrophoretic mobility disappeared when the hæms were detached from the globin, the mobilities of the globins being identical.

Sherman[4] observed that the 'sickled' cells were birefringent. Some months ago, Dr. C. A. Stetson, of the Rockefeller Institute, suggested to us that the actual process of 'sickling' bore some resemblance to crystallization, in that a structural change can be observed to spread through the cells from a focus. He supplied us with a small sample of anæmia cells, while Dr. F. Eirich, who had first directed our attention to this peculiar disease, gave us a sample of sickle-cell hæmoglobin solution.

## Structure of 'Sickled' Cells

The red cells were suspended in 0·1 *M* phosphate buffer at *p*H 7 saturated with hydrogen sulphide, and sealed on a slide. The slides were examined under a polarizing microscope of high sensitivity developed by Swann and Mitchison[5]. Between crossed nicols, without compensation, the sickled cells lit up in a deep blue colour and became extinguished completely at every 90° rotation of the stage. In the case of the straight tubular cells, extinction was parallel to the length of the tubes. There could be no possible doubt about the birefringence of the cells. It should be added that normal red cells show no birefringence.

Introduction of an elliptical compensator produced the series of colour changes illustrated in Fig. 1. When the slow-vibration direction of the compensator was parallel to the length of the cells, their colour changed from deep blue to violet and finally to green; when the compensator was turned the other way, the colour changed to pale pink and white. The orientation of these effects was the same in all cells. The colours observed were totally different from the normal interference colours of birefringent crystals in polarized light, and were suspected to be due to the presence of crystalline reduced hæmoglobin in the sickled cells.

A crop of normal human reduced-hæmoglobin crystals of a size similar to that of the sickled cells was now prepared. Most of these crystals were prismatic needles of the type shown in Fig. 1 and corresponding to the crystals in Fig. 6 of Jope and O'Brien's work[7]. Between crossed nicols they showed a deep blue colour and straight extinction, just like the sickled cells. Introduction of an elliptical compensator produced the identical series of colour changes, with the long axis of the crystals corresponding in direction to the length of the cells. These observations indicated that the sickled cells did indeed contain crystalline reduced hæmoglobin, and that the needle axis of the crystals was parallel to the length of the cells.

The larger crystals had a marked dichroism, with the direction of strong absorption normal to the needle axis, which shows that the hæm groups are oriented roughly normal to the needle axis[6]. This indicates that these groups are also oriented normal to the length of the anæmia cells (Fig. 1).

R 294

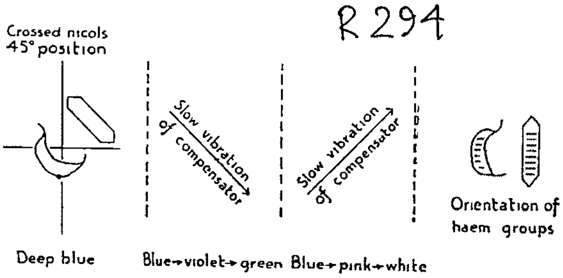
Crossed nicols
45° position
Slow vibration of compensator
Slow vibration of compensator
Orientation of haem groups
Deep blue
Blue→violet→green
Blue→pink→white

Fig. 1. Colours shown by sickled-cell and thin reduced hæmoglobin crystal between crossed nicols without and with compensation. The orientation of the hæm groups is indicated on the right

It was surprising to discover that some of the hæmoglobin had crystallized in the form of sickles apparently composed of a fan-like assembly of plates. The resemblance in shape between these crystals and the sickle cells was suggestive; on the other hand, the linear dimensions of the crystals were about ten times larger than those of the sickled cells.

## Origin of the Anomalous Colours

This was investigated by measuring the dispersion of the birefringence of the reduced hæmoglobin crystals. The retardation of a thin crystal plate was measured at a series of monochromatic wave-lengths, using interference filters of band-width 0·015 μ made by the Farrand Optical Co. and kindly lent to us by Lord Rothschild. Fig. 2 shows the dispersion curve of a crystal over the visible spectrum; the light-absorption curve of reduced hæmoglobin in solution is plotted for comparison.

The relation between the two curves is readily understood if the theory of anomalous dispersion is applied to the case of a dichroic crystal. In accord-

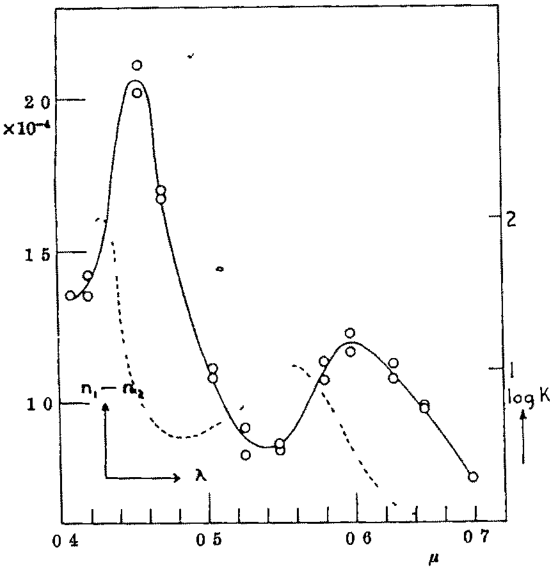

Fig 2 Full curve dispersion of the birefringence of normal human reduced hæmoglobin crystal (ordinate on left) The absolute birefringence scale is approximate, due to uncertainty of the crystal thickness Dashed curve absorption coefficient of human reduced hæmoglobin in solution[10] (ordinate on right)

ance with this theory, the refractive index of one plane-polarized ray, which is strongly absorbed, rises to a maximum on the long-wave side of each absorption band and drops to a minimum on the short-wave side of each band, while the refractive index of the other plane-polarized ray, which is not absorbed, is unaffected Hence the retardation between the two rays rises and falls near each absorption band, just as observed The birefringence should actually be reversed in sign, as the refractive index of the strongly absorbed ray should become negative on the short-wave side of absorption bands, evidently this is prevented here either by the contribution of the protein to the birefringence of the crystals or by the overlapping of the two maxima

The anomalous colour effects can be well explained by the dispersion curve Since the retardation is greatest in the violet and blue, very thin specimens will actually show a mixture of those colours When a compensator is introduced in the subtraction position, retardation is only visible from the peak value in the violet Further subtraction reverses the birefringence, so that the crystals now show the colours where their natural birefringence is least, that is, in the green

## Solubility of Hæmoglobin

There is a marked solubility difference between the reduced hæmoglobin of normal human blood and of blood from sickle-cell anæmia patients The solubilities were measured at 20° C in phosphate buffer at *p*H 6 8, prepared by mixing 0 58 and 0 42 mole fractions of dipotassium hydrogen phosphate and potassium dihydrogen phosphate respectively The results are plotted in Fig 3, which shows the solubilities of sickle oxyhæmoglobin and methæmoglobin to be normal within the limits of error The solubility of normal human reduced hæmoglobin is about half that of the oxyhæmoglobin, in accordance with the findings of Jope and O'Brien[7] The solubility of the sickle-reduced hæmoglobin, on the other hand, is no more than one-hundredth of that of the oxyhæmoglobin

The differences between the solubilities were also found to be of the same order at physiological *p*H (7 3) They were found in both the samples provided to us, which came from different patients, and they were independent of the method of preparation of the proteins

## Discussion

The hæmoglobin in normal red cells and oxygenated sickle cells is almost certainly not crystalline Such cells are not birefringent in plasma, and there is evidence that the hæmoglobin molecules are randomly oriented[8] Our experiments, however, indicate that the reduced hæmoglobin in sickle cells is in a crystalline state These observations, taken together with the abnormally low solubility of the reduced sickle hæmoglobin, suggest a simple mechanism for the reversible changes in shape undergone by the anæmia cells It appears as though on de-oxygenation the hæmoglobin crystallizes inside the red cell, and that on oxygenation it goes back into solution The change in shape would be forced upon the cells partly by the habit of the crystals and partly by the loss of water which would be expected to accompany crystallization For while red cells contain 34 per cent hæmoglobin, crystals contain between 50 and 60 per cent The surplus water not enclosed in the crystals, being almost free of protein, would tend to diffuse out of the cells through loss in osmotic pressure, thus causing the cell membrane to collapse

For the time being, this explanation must remain tentative, and far more work is needed to clear up the problem completely In the first place, we should be more certain of our ground if the solubilities had been determined at physiological ionic strength, which could not be done for lack of material Secondly, there is nothing to show, so far, that the pathological changes of the red cell in sickle-cell anæmia are confined to the hæmoglobin Other differences both in the cytoplasm and in the cell membrane may well exist this is suggested, for example, by the difference between the resistance to lysis of normal red cells and sickle anæmia cells, even in the oxygenated state of the hæmoglobins[9] Thirdly, several hæmoglobins

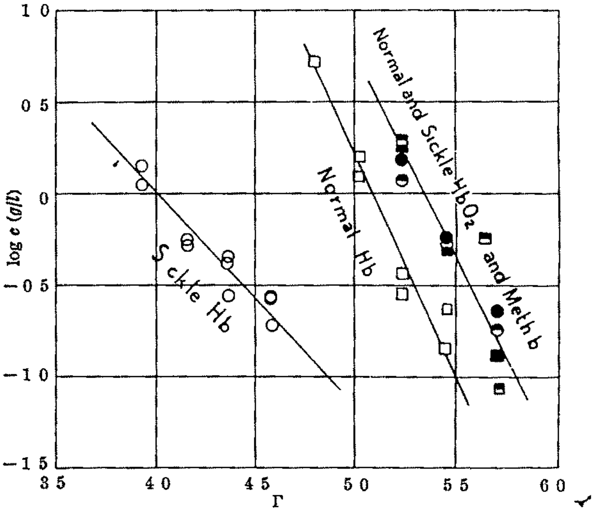

Fig 3 Solubilities of normal and sickle hæmoglobins plotted against ionic strength of phosphate buffer $\Gamma = \frac{1}{2}\sum_i c_i z_i^2$, where $c_i$ is the concentration of each ion in moles/litre and $z_i$ its valency

are known, for example, those of guinea pig or rat, which are extremely insoluble, but nevertheless normally exist in solution in the red cell No one, in fact, has yet demonstrated the existence of crystalline hæmoglobin inside any kind of red cell *in vivo* or under strictly physiological conditions Under non-physiological conditions it has been observed in many instances[11-15] Owsjannikow described the crystallization of hæmoglobin inside the red cells of fishes, leading to elongation of cells He also obtained crystals inside the red cells of rabbits, dogs, cats and guinea pigs[14] Teitel Bernard[15] showed that the hæmoglobin in human red cells can be crystallized by immersing the cells in slightly hypertonic saline buffered to *p*H 6 5, and leaving them for some hours or days The appearance of his cells suggests that they contain reduced hæmoglobin crystals of the form shown in Fig 5 of Jope and O'Brien's work[7]

One of the most interesting problems emerging from this study is the great change in physico-chemical properties which hæmoglobin undergoes on combining with oxygen This change may be exceptionally pronounced in sickle-cell anæmia; but similar, though often lesser, differences between reduced and oxyhæmoglobin have been found in all animal species so far investigated and are as yet totally unexplained

We wish to thank Dr F Eirich and Dr C A Stetson for bringing this interesting problem to our attention and for providing us with specimens, and Prof D Keilin for his valuable criticism We are also indebted to the Medical Research Council for financing this work

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# WALDEN INVERSION AND REACTION MECHANISM

## Walden Inversion in Unimolecular Reactions of Secondary and Tertiary Alkyl Halides

ONE of the rules, given in our papers of 1937 on the relation of the Walden inversion to reaction mechanism[1], was that unimolecular substitutions, $S_N1$, of alkyl compounds involve racemization with excess of inversion, the excess diminishing when conjugation increases the stability of the intermediate alkyl cation The evidence underlying this conclusion was, however, complicated It depended on results obtained with optically active secondary alkyl halides, the unimolecular reactions of which are often difficult to obtain in a pure form, even aqueous solvolysis, although largely unimolecular, involving an appreciable, but not closely estimated, bimolecular component Tertiary alkyl halides, which readily undergo pure unimolecular reactions, were then unavailable in optically active forms

We have now improved the basis of the rule, first by developing new methods for mechanistic analysis of the solvolysis of secondary halides, and secondly, by studying the solvolysis of an optically active tertiary halide

The method of mechanistic analysis was outlined in 1946, as a proposal based on our then new knowledge of the conditions in which one may completely suppress bimolecular substitution, $S_N2$, by steric hindrance[2] By using systems such as $(CH_3)_3C\,CH_2\,Cl$ and $(CH_3)_3C\,CHMe\,Cl$, one can secure the pure unimolecular solvolysis, $S_N1$, of even a primary and a secondary halide, the solvolysis of the related tertiary halide $(CH_3)_3C\,CMe_2\,Cl$ is, of course, unimolecular By changing the state of alkylation of $C_\beta$, it has been confirmed that unimolecular substitution is not, as bimolecular substitution certainly is, subject to steric hindrance , and also that β-alkylation has no great polar effect , so that its overall kinetic effect on unimolecular substitution is small, as is illustrated by the following Arrhenius parameters ($E$ in kcal , $B$ in sec$^{-1}$) for the solvolysis of $RCMe_2Cl$ in 80 vol per cent aqueous ethyl alcohol.

| $R$ | $CH_3$ | $CH_2Me$ | $CHMe_2$ | $CMe_3$ |
|---|---|---|---|---|
| $E$ | 23 1 | 22 9 | 23 3 | 23 8 |
| $\log_{10}B$ | 11 9 | 11 9 | 12 0 | 12 5 |

On the contrary, α-alkylation has a large kinetic effect , and therefore, as regards unimolecular solvolysis, alkyl halides can be divided sharply into the three classes, primary, secondary and tertiary, each class having kinetic constants which are nearly independent of other details of the alkyl structure, though they do depend on the halogen and the medium For example, we may set down $E$-values for bromides in 80 vol per cent aqueous alcohol as follows

| Bromide | Primary | Secondary | Tertiary |
|---|---|---|---|
| $E$ (kcal ) | 30 0 | 26 7 | 23 3 |

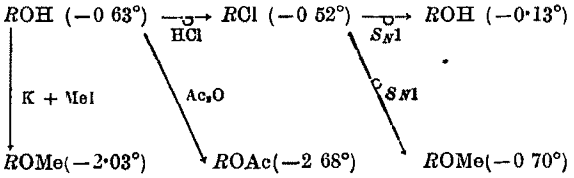
Now when those simple halides are examined for which bimolecular solvolysis is not structurally precluded, it is found that the kinetic constants for the solvolysis of tertiary halides conform to type, but that those of the secondary and primary halides deviate from the relevant unimolecular values That is because the solvolyses of these secondary halides are partly, and of the primary halides are very largely, bimolecular From the kinetic constants given by the secondary halides, it is possible to estimate the proportions of the unimolecular and bimolecular reactions We thus find, for example, that at least 75 per cent of the solvolysis of β-*n*-octyl bromide in 60 vol per cent aqueous ethyl alcohol is unimolecular The observed 66 per cent preservation of optical activity with inversion of configuration[1] is clearly more than could be credited to the bimolecular part of the reaction , and thus the conclusion is confirmed that unimolecular solvolysis entails an excess of inversion.

As a convenient source of optically active tertiary alkyl compounds, methylethyl*iso*hexylcarbinol was prepared by catalytic hydrogenation of linalool The (−)alcohol was converted into the (−)chloride[3] through the agency of (*a*) hydrogen chloride, (*b*) thionyl chloride, (*c*) thionyl chloride and pyridine, and (*d*) phosphorus pentachloride, all general methods which have been shown to produce inversion of configuration It could not be established for any preparation of the chloride that no optical purity was lost, an attempt by our usual method of back-conversion in kinetically controlled bimolecular conditions ($S_N2$) was frustrated by a large incursion of olefin formation ($E2$). The (−)alcohol was converted, through its potassium salt and methyl iodide, into the (−)methyl ether, and, with the aid of acetic anhydride, into the (−)acetate, reactions which leave untouched the asymmetric centre It follows that the (−)alcohol, the (+)chloride, the (−)methyl ether, and the (−)acetate have corresponding configurations

The hydrolysis of the chloride in 80 vol per cent aqueous acetone was followed kinetically ($k_1$ at 60°, 1 58 × $10^{-4}$ sec $^{-1}$), and shown to be unimolecular, it could not be appreciably accelerated by added alkali Under mildly alkaline conditions, the (−)chloride gave a (−)alcohol with 21 per cent of the optical activity of the original alcohol, and therefore at least 21 per cent of the activity which would have resulted from a completely non-racemizing hydrolysis The alcohol was shown to be optically stable under the conditions of its production

The alcoholysis of the chloride in anhydrous methyl alcohol was shown to be unimolecular ($k_1$ at 60°, 2 74 × $10^{-4}$ sec $^{-1}$), added sodium methoxide producing only a slight acceleration Under mildly alkaline conditions, the (−)chloride gave a (−)ether with 34 per cent of the activity of ether prepared by methylation of the original alcohol, and therefore at least 34 per cent of the activity which would have resulted from a non-racemizing alcoholysis The ether was optically stable in the conditions of its production, though it was rapidly racemized in acidic methyl alcohol

The rotations indicated below ($\alpha_D^{17°}$, $l = 10$) were measured in the experiments mentioned



The symbol $\underset{\cup}{\longrightarrow}$ indicates predominating inversion of configuration It is satisfactory that excess of inversion is now realized in demonstrably pure $S_N1$ reactions

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[1] *J Chem Soc*, 1196 *et seq* (1937) (six papers)

[2] *ibid*, 157 *et seq* (1946) (seven papers)

[3] Stevens and McNiven *J Amer Chem Soc*, **61**, 1295 (1939)

# Walden Inversion in the Acid Hydrolysis of Carboxylic Esters by Unimolecular Alkyl Fission

One of the less thoroughly investigated of the seven mechanisms of carboxylic ester hydrolysis, which Day and Ingold listed and associated with observed or predicted structural, kinetic and stereochemical characteristics[1], is the acid-catalysed, unimolecular reaction involving alkyl-oxygen fission, $-A''1$ as they labelled it, or $A_{AL}1$ as we now prefer to write

$$R'\mathrm{CO\,O}R \overset{\text{fast}}{\rightleftharpoons} R'\,\mathrm{CO}\,\overset{+}{\mathrm{O}}\mathrm{H}R \overset{\text{slow}}{\rightleftharpoons} R'\mathrm{CO_2H} + \overset{+}{R} \overset{\text{fast}}{\rightleftharpoons} R'\mathrm{CO_2H} + R\mathrm{OH} \qquad (A_{AL}1).$$

This mechanism was expected to be easily realizable when $R$ was a tertiary alkyl group Having an optically active tertiary alkyl acetate in our hands (see preceding note), it was an obvious task to set up the conditions for $A_{AL}1$ hydrolysis, and to verify the stereochemical course of the process

The base-catalysed hydrolysis of methylethyl*iso*hexylcarbinyl acetate was first examined The reaction with 0 02–0 04 $N$ sodium hydroxide in 64 vol per cent aqueous dioxan had the kinetic form rate = $k_2$ [ester] [$\bar{\mathrm{O}}$H] (with $k_2$ = 2 82 × $10^{-3}$ sec $^{-1}$ gm -mol $^{-1}$ l at 90°) The alcohol produced had a retained configuration and 99 per cent of its original optical activity Obviously this is the usual base-catalysed, bimolecular reaction with acyl-oxygen fission, $B_{AC}2$

$$R'\mathrm{CO\,O}R \xrightarrow[\text{slow}]{} R'\mathrm{C}(\bar{\mathrm{O}})(\mathrm{OH})\,\mathrm{O}R \xrightarrow[\text{fast}]{} R'\mathrm{C}\bar{\mathrm{O}}_2 + \mathrm{HO}R \qquad (B_{AC}2)$$

The acid hydrolysis with 0 01–0 06 $N$ hydrogen chloride in 70 vol per cent aqueous acetone had the kinetic form rate = $k_2$ [ester] [$\overset{+}{\mathrm{H}}$] (with $k_2$ = 10 4 × $10^{-3}$ sec $^{-1}$ gm -mol $^{-1}$ l at 76 1°). Samples of alcohol recovered from hydrolyses with 0 02 $N$ hydrogen chloride had predominantly inverted configurations, and 9–12 per cent of the maximal optical activity It has to be taken into account that the alcohol itself undergoes racemization in these acid solutions. The rate of this process having been determined, it was computed that the alcohol, as freshly produced by hydrolysis, had about 19 per cent of its maximal activity

The following rotations ($\alpha_D^{17°}$, $l = 10$) were measured in these experiments

$$\begin{array}{lll} R\mathrm{OH} \xrightarrow{\mathrm{Ac_2O}} R\mathrm{OAc} & \left\{ \begin{array}{l} \xrightarrow{\mathrm{O\bar{H}}} R\mathrm{OH}\ (-0\ 62°) \\ \underset{\cup}{\xrightarrow{\overset{+}{\mathrm{H}}}} R\mathrm{OH}\ (+0\ 06° \text{ to } +0\ 08°). \end{array} \right. \\ (-0\ 63°)\quad (-2\ 68°) & \end{array}$$

Evidently the acid reaction is producing racemization with some excess of inversion, as would be expected from the presumed mechanism and the general rules governing the stereochemistry of substitution The smallness of the resulting activities shows that acid-catalysed bimolecular alkyl-fission (mechanism $A_{AL}2$) is either absent, or present to only a small extent.

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# EIGHTEENTH INTERNATIONAL PHYSIOLOGICAL CONGRESS

THE Eighteenth International Physiological Congress met at Copenhagen during August 15-18 It was attended by more than 1,200 members who contributed some six hundred communications To accommodate these numbers was a formidable undertaking, and it was generally felt that the organisers had managed to perform their task smoothly and with admirable efficiency When opening the Congress, Prof. E Lundsgaard paid a tribute to the memory of the late Prof August Krogh, and somewhat diffidently referred to the fact that he himself was presiding only as a substitute, but at the end there was little doubt that he and his helpers, particularly the general secretary, Prof P Brandt Rehberg, had excelled themselves in managing the affairs of the Congress, and the gratitude of members was well expressed by the applause with which Prof Lundsgaard was greeted when he made his final appearance

There were seven half-day business sessions, four of which were reserved for the presentation of individual short papers, while three were devoted to "General Discussions" of selected problems. To distribute the load, the proceedings were divided into several simultaneous sections two or three general discussion meetings were held at a time, and individual papers were presented in ten different halls, where each paper had to be read and discussed in fifteen minutes It is, therefore, impossible for any one person to report on more than a small fraction of the transacted programme The present writer's main interest lies in the field of nerve and muscle function and the properties of excitable cell membranes, so that he found no time to attend discussions on other matters, and even had to miss some important contributions within his own narrow field of interest

The session which stands out most in the writer's memory was a discussion on the transport of substances across cell membranes, in which important papers were read by Prof E J Conway, H H Ussing, and A L Hodgkin and A F Huxley The authors dealt with such different subjects as fermentation in yeast cells, secretion of the gastric mucosa, transport of salt and water across frog skin, and ionic exchange mechanism during the nerve impulse In spite of the different materials and methods of approach which [illegible] uthors had chosen, it was interesting to observe [illegible] ey tended to arrive at a common postulate, [illegible] he existence in the cell membrane of 'carrier- [illegible] with specific affinities for certain cations [illegible] nces may be thought of as specific [illegible] tors for potassium, sodium or hydro- [illegible] ars that the functional activity of [illegible] upon some form of 'activation' or [illegible] hese cation-carriers. But apart [illegible] ve ideas, a wealth of quantitative [illegible] presented on the movement of [illegible] f ions across membranes and the [illegible] ir movement can be controlled [illegible] trical potential gradients The [illegible] arly impressed by the argument [illegible] ey, who supplied precise figures [illegible] of sodium and potassium ions [illegible] mbrane and concluded that the t [illegible] ons is responsible for the electric cu [illegible] nerve impulses are transmitted In t [illegible] esting nerve cell, no net entry of sodium occurs, in spite of the high inward gradient of its electro-chemical potential But it appears that a large surge of sodium current, in the direction of this gradient, occurs when the cell membrane is suddenly depolarized This transient state of rapid sodium transfer is followed by a maintained state of rapid potassium outflux Hodgkin and Huxley showed that the magnitude and direction of the 'sodium surge' can be controlled, in a theoretically predictable manner, by varying either the potential, or the sodium concentration, gradient across the membrane On the basis of these findings, it is possible to explain and to reconstruct the events which take place during excitation and the propagation of nerve impulses The immediate source of energy which is utilized during the transmission of the impulse appears to be the thermal energy of sodium and potassium ions, and active metabolic processes are only called upon slowly to restore and maintain the electro-chemical gradients of the resting cell During the discussion which followed, Prof von Muralt paid a generous tribute to the high quality and importance of this work, and the audience gained the same impression during a later session in which A L Hodgkin and R D Keynes showed some elegant and decisive ways of employing radioactive tracer techniques in a study of ionic movements in nerve axons As a by-product of this work, direct proof is now available to show that the activity and mobility of potassium ions in the nerve axoplasm is equal, or nearly equal, to that in an aqueous solution.

Among other papers which impressed the writer as new and very important was H H Weber's contribution to the discussion on muscle function, in which he showed that the actomyosin – adenosine triphosphate system resembles contracting muscle much more closely, in its mechanical properties, than was previously believed

There were many other important contributions, both during the discussion meetings, and the sessions in which individual papers were presented A symposium on the thermodynamics of muscle was opened by Prof A V Hill, followed by A Szent-Gyorgyi The factors affecting cardiac output in man were discussed by A Cournand, J McMichael and G Nylin Profs C H Best and B A Houssay introduced a conference on the hormonal control of fat metabolism, and the properties of the retina were reviewed by Drs R Granit, H J A Dartnall and Prof H Hartridge A discussion of the principles of spinal cord activity was introduced by F Bremer, D P C Lloyd and C G Bernhard, and a session concerned with the problems of salt and water excretion was opened by H W Smith and E B Verney

In certain sections (for example, those dealing with nerve and muscle function, and with general cell physiology) a good deal of new information was reported which depended upon the recent adaptation of two methods first, the use of radioactive isotopes in studying the properties of cell surfaces, and secondly, the use of the intracellular recording electrode introduced some years ago by R W Gerard

Inevitably, the papers which have been mentioned here represent only a very narrow selection of the large amount of important material that was presented

Most members appeared to be very well satisfied with the friendly spirit and the interesting results of this Congress, but many of them must have pondered over the problems posed by the heavy and increasing weight of numbers at such international gatherings Some further experimentation along the line of 'general discussion meetings' would seem to be required, though many such meetings suffer from the fact that too much time is taken up by long 'introductory' papers which leave little opportunity or desire for general discussion afterwards To achieve a more vivid interchange of ideas and information, it might perhaps be better to have at each session a single introductory review followed by informal discussion It would also seem that such sessions require some preparatory work by which the organiser approaches individual colleagues in his field to ensure an adequate response

It is perhaps doubtful whether there remains very much use for sectional sessions in which large numbers of individual papers follow one another, often with little or no connexion and little or no time for questions If it is felt desirable to retain such sessions, members might at least be discouraged from including papers which have already been published in full But criticisms such as these are a very minor matter compared with the good that comes from personal contact and the great stimulus that everyone can derive by challenging in private session his scientific friends and opponents

At the closing session an invitation was received and warmly welcomed to hold the next, the Nineteenth International Physiological Congress, at Montreal in 1953

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# CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR THE PROTECTION OF INDUSTRIAL PROPERTY

THE resolutions passed at the Congress of the International Association for the Protection of Industrial Property, held in Paris during June 1950, which have now been published, assume a wider significance in view of the measures being taken in other directions to effect the economic integration of Europe The Association is an informal body comprising industrialists, patent agents, solicitors and barristers who are directly concerned with questions relating to inventions, patents, trade marks and copyright The expression "Industrial Property" is a convenient portmanteau phrase for describing commercial rights connected with international trade and industry in these matters

The conception of a uniform international law in the limited field of industrial property is old The Association was formed in the seventies of the past century with the object of remedying the insuperable difficulties which then faced a manufacturer or trader in one country in securing protection for his inventions or trade marks in foreign countries

Prior to 1883, there were a number of bipartite treaties entered into between various countries which specifically dealt *inter alia* with the protection of industrial property rights In 1883, however, an International Convention for the Protection of Industrial Property was concluded in Paris, which laid down certain general principles to be applied by the member States in the manner best suited to their own systems of legislation so as to facilitate international trade and to prevent all kinds of unfair trading The Convention has been periodically revised, the last revision having been undertaken at a diplomatic conference in London in 1934

The resolutions passed at the recent Congress of more than four hundred delegates from about forty countries are to be submitted to the Governments of all these countries, as the next revision of the Convention is due to be undertaken at a diplomatic conference in 1951 A summary of the more important resolutions which were passed unanimously is given under the three headings of general resolutions, resolutions dealing with patents, and resolutions dealing with trade marks, as follows

*General Resolutions* The Congress proposed the adoption in the Convention of an Article that "any dispute between two or a number of Convention countries concerning the interpretation or the application of the general Convention and of the restricted Conventions which is not settled by negotiation shall be referred to the International Court of Justice [at the Hague] for decision by the latter, unless the countries in question agree upon another method of settlement" In order to prevent the exercise of the power of the veto by one country in suppressing amendments to the Convention, it was resolved that there should be incorporated in the Convention and in the arrangements depending on it the declaration that all amendments approved by at least four-fifths of those voting should be adopted

*Resolutions dealing with Patents* A number of amendments dealing with priority rights in connexion with patents and designs were adopted Thus, at any time up to the final grant of his patent, an applicant should have the right to divide his application, preserving for his new application the benefit of his original application

Again, failure to work in a Convention country an invention which is the subject of a patent granted in that country, or the introduction by the patentee into that country of objects manufactured in another Convention country, shall not lead to revocation of the patent However, in order to prevent abuses which might result from the exercise of the exclusive right conferred by the patent, each Convention country shall be entitled to impose legislative measures providing for the grant of compulsory licences to any qualified applicant In no case should a compulsory licence be asked for before five years from the date of the application of the patent or three years from the grant, whichever shall be the longer The grant of a licence should be refus[illegible] the patentee can legitimately justify his fa[illegible] work the invention A resolution was ad[illegible] posing a new measure to the effect tha[illegible] certificates of addition shall be freely [illegible] principal patents on the application[illegible]

It is interesting to note that man[illegible] ments will have the effect of bringi[illegible] the Convention more into line [illegible] patent law in Great Britain as s[illegible] Act of 1949

*Resolution dealing with Trade Marks* [illegible] tions in regard to trade marks were probably of more immediate and of wider importance to present conditions of international trade Questions relating to the assignment and licensing of trade marks have caused considerable commercial difficulties The function of a trade mark is not to indicate ownership, but rather to guarantee that goods bearing a trade mark have certain standards of quality The recognition of free assignability and licensing of trade marks is particularly necessary in international trade to-day where the owner must part with the title or use of his trade mark in order to be able to make it available in another country.

The Congress passed a resolution that the principle of free assignment of trade marks should be adopted by all Convention countries, subject to such limitations as the domestic law of each country requires to prevent deception of the public by the transfer of the mark. A further resolution was passed embodying the principle that persons other than the registered owner may use a trade mark provided that effective control of the use could be ensured by the proprietor, and subject again to such limitations as the domestic law of each country required, so as to prevent the use from deceiving the public.

Several other resolutions of lesser importance dealt with the prevention of unfair trading. When goods have been sold under a trade name which is a word in the vernacular of one of the countries, it may happen that a trader in another country may attempt to market similar goods in that foreign country under the name which is a translation of this word. This practice causes great difficulties and frequently leads to deception of the public. These difficulties would be overcome by the adoption of the principle that the Convention countries will accept and register, in one and the same operation, composite trade marks comprising the mark in the language of origin and its translation into other languages, each element of the composite mark being protected in itself.

These resolutions were supported in principle at the Conference of the International Bar Association held in July in Great Britain.

The adoption of these resolutions at the diplomatic conference of Governments will be a great step forward to the end that problems of international law in regard to industrial property may receive uniform solution in all countries which are party to the International Convention.

R. G. LLOYD

# ELEVENTH INTERNATIONAL CONGRESS OF THEORETICAL AND APPLIED LIMNOLOGY

THE Eleventh International Congress of Theoretical and Applied Limnology held in Belgium was attended by about eighty people representing seventeen different nations; but, despite the small number of participants, the vigorous exchange of opinion between all and sundry was a testimony to its great value. At the opening session, held in the fine assembly hall of the University of Ghent on the evening of August 16, the members were addressed by the president of the International Limnological Association (Dr. Gunnar Alm) and heard a lecture by the chairman of the Organising Committee (Prof. P. van Oye) on "The Beginnings of Limnology in Belgium". The six scientific sessions, at which upwards of forty papers on a wide range of topics were read, were held in the four university towns, Ghent, Brussels, Louvain and Liège, between August 17 and 23. Among many noteworthy contributions special mention may be made of those by Dr. Thomas (Zurich) on the nature of the monthly sediments deposited in certain Swiss lakes, by Dr. C. H. Mortimer (Windermere) on water movements in stratified lakes, by Prof. W. Rodhe (Uppsala) on a method of sampling and analysis of lake waters by ion exchangers, by Dr. M. Lefèvre (France) on antagonisms between successive populations of freshwater algæ, by Prof. d'Ancona (Padua) on the changes induced by the environment on the marine plankton in the lagoons of Venice, and by Prof. Lenz (Plön) on problems concerning chironomid ecology, the last in particular leading to a lively discussion.

On the Sunday afternoon a visit was paid to the Congo Museum at Tervuren near Brussels, where the members of the congress were entertained to tea by the Director and his wife. Similar hospitality was afforded us on several other occasions. In the course of the journey from Brussels to Louvain the large centre for fish-culture at Linkebeek was visited under the guidance of the director of applied limnology, Dr. M. Huet, who also led a three-days tour of south-east Belgium during August 24–26, comprising visits to the principal rivers, to the Michel dam, to the thermal establishment at Spa, and to the grottoes at Han. At the concluding session held at Liège on August 23, a committee consisting of Drs. Mortimer, Ohle and Rodhe was appointed to study and co-ordinate and, if needs be, initiate, new methods for hydrobiological investigation. The next congress will be held in Cambridge during August 1953.

F. E. FRITSCH

# AIRCRAFT-LANDING AIDS IN BAD VISIBILITY

AT a meeting held at Birmingham on September 5 of Section A (Mathematics and Physics) of the British Association, Mr. E. S. Calvert presented a paper entitled "Visual Aids for Landing in Bad Visibility, with Particular Reference to the Transition from Instrument to Visual Flight". Mr. Calvert said that during the past five years radio approach aids have been installed at all major airports to enable aircraft to land in conditions of bad visibility or low cloud. By means of these aids a pilot who is adequately trained in instrument-flying can align his aircraft with the runway and bring it down to a height of about 200 ft. without seeing the ground. The rest of the approach and landing, however, have to be made visually, and this means that the pilot has to make a rapid transition from instrument to visual flight when near the ground. At 200 ft. the aircraft is still about three-quarters of a mile from the end of the runway, and to bridge this gap a pattern of lights about 1,000 yd. long is laid down in the approach area. This pattern must be such that a pilot seeing only a portion of it can determine the aircraft's attitude, position and direction of motion, and the rates at which these are changing. The lights must be suitable for use by day as well as by night, and for this reason have to be of high intensity. The intensities being used at present are of the order of 100,000 candles.

During the radio portion of the approach, the pilot obtains his positional information either by listening to a voice in his earphones, or by looking at a meter on his instrument panel. From this he has to find the heading which will bring him on to the runway, a task which is particularly difficult when there is a cross-wind which varies with height. He also has to watch his flight instruments and manipulate the controls. His mind is therefore fully occupied when he sees the lights, and transition from instrument to visual flight is difficult If he makes the transition at 250 ft, then he will be flying on visual references for only 30 sec prior to touch down With improved instrumentation the aircraft could perhaps be brought down to 100 ft, in which case this time would be reduced to 15 sec The problem is, therefore, to find a pattern for the approach lights which will provide indications which the pilot can interpret instantly without having to use mental processes different from those which he has learnt to use in good-weather flying

The first patterns to be tried consisted of single and multiple lines parallel to the extended centre-line of the runway, and these were followed by vees and funnels Flight tests on these patterns extending over several years showed that in bad visibility the impressions of the pilot when he first picks up the lights often fail to correspond with the real situation In other words, his first impressions are often illusions Three illusions are commonly reported as follows (1) The runway lights appear to 'float in space', or 'stand on end', that is, they appear as an inverted vee in the vertical plane instead of a pair of parallel lines in the horizontal plane Also the pattern has 'no depth' and appears to be at a varying distance As a result the pilot 'loses his ground plane' and has a strong impulse to pull up (2) The approach lights appear to 'swing from side to side' or 'drift out of the field of view', so that instead of descending on a straight course, the pilot 'weaves' from side to side (3) A strong impression of the horizon is suddenly built up in the pilot's mind, although he knows that he cannot tell where the horizon is without referring back to his instruments. When the pilot is suffering from fatigue or is in a state of mental stress, this conflict causes feelings of confusion and frustration, and in extreme cases of vertigo

These illusions have been studied statically by means of perspective diagrams, and kinematically by means of landing simulators It was found that when the effect of fog is simulated by removing the horizon, the visual indications become geometrically indeterminate. In other words, the same picture represents a large number of different situations If, therefore, a pilot tries to correct an error by observing only the visual indications, he can scarcely avoid being confused by their ambiguity

Mr. Calvert then showed that the indications can be made geometrically determinate by using a pattern consisting of a line of lights along the centre-line with bars of lights running transversely across it at intervals The reason for this is that the bars supply the indication of the horizontal which is missing in the other patterns This pattern, which is now known as the 'crossbar system', was installed at London Airport in November 1948, and shortly afterwards about a dozen installations were laid down in Germany, mostly for the 'Berlin Air Lift' All reports agree that the transition is consistently easy and safe, and no illusions have been reported

Mr Calvert then described a new theory of visual judgment which has been developed as a result of collaboration between Capt Majendie of B O A C and his own group at the Royal Aircraft Establishment This theory, which is known as the 'parafoveal streamer theory', is briefly as follows When the aircraft is several miles from the runway the angular subtense of the pattern and the rate of change of the perspective image are small, and the pilot makes his judgments by scanning the pattern and comparing the perspective image with an ideal one which he carries in his memory As the aircraft comes closer to the pattern, its angular subtense and the apparent velocity of the lights increase At about 150 ft the pilot begins to stare straight ahead with his head and eyeballs fixed After this, he derives his impressions of height and direction of motion mainly from the pattern formed by the paths which the retinal images of the lights trace out on the parafovea, and from the velocity of the images along these paths These paths may be called 'streamers', the pattern a 'streamer pattern', and the image velocity the 'streamer velocity' The reason why the pilot stares is that it is easier to judge streamer patterns and streamer velocities if he keeps his eyeballs fixed, because in that case the only changes in the retinal image are those due to changes in the streamer pattern and streamer velocities

Capt Majendie opened the discussion by showing a film which he had taken of the faces of various pilots when making landings These showed clearly that at heights below about 150 ft the pilot's head is rigid, and the eyes are staring straight ahead, except for occasional quick glances at an instrument or an obstruction The film also showed some calibrated eye-movements which indicated that a movement of 1° could just be detected

Mr Glenny then showed some films of landings in very bad visibility which had been made in America by the Sperry Gyroscope Co These also showed a high degree of fixated vision at low heights A noticeable feature of both films was the expression of strain on the faces of the pilots

Mr Parker, speaking on behalf of the Ministry of Civil Aviation, said that the 'crossbar system' at London Airport has been very successful During the past two winters many landings with passengers have been made on it in visibilities as low as 300 yards The principles on which it is based are now generally accepted in Great Britain, and are being increasingly accepted abroad It is one of three systems recommended by the International Civil Aviation Organisation, and about eight foreign countries are already installing it at their major airports It is therefore quite possible that the 'crossbar system' will become the standard approach lighting system of the future

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# PERIODIC FLUCTUATION IN THE LENGTH OF THE DAY

A PAPER by H F Finch "On a Periodic Fluctuation in the Length of the Day"[1] gives a full account of the performance of a number of quartz-crystal clocks employed in the Greenwich Time Service Soon after the introduction of quartz clocks, their errors on a long-term basis were predicted, and the clock correction $E$ was represented very closely by the expression $E=a+bt+ct^2$, where $t$ is reckoned in time from some arbitrary epoch, and $a$, $b$, $c$ are constants the values of which were derived from a series of time determinations extending over many months

By applying the adopted current corrections to the standard clocks and using daily intercomparisons, it was possible to deduce the amount of correction for the clock controlling the time signal, prior to transmission Although the method succeeded for a time, in the autumn of 1945 the observed clock corrections began to diverge from those predicted, the clocks appearing to have undergone an acceleration of rate, and a retardation in the period of rotation of the earth was suspected. In subsequent years, as more clocks became available, the same phenomenon was in evidence, but it was not until the spring of 1949 that a definite retardation among a number of clocks was noticed. The suspicion of a seasonal fluctuation in the earth's period of rotation led to an examination of the final corrections to the times of emission of the Rugby time signals which are under the control of the Greenwich Time Service, and a full account of the investigations and the conclusions is given in Finch's paper.

It appears that there is a variation of the order 0.001 sec. and an accumulative effect in time of approximately 0.060 sec. Similar results were obtained by N. Stoyko[2], who published his investigations during 1936–37, but his work did not receive much attention at the time. An attempt to account for the phenomena of the slowing of the earth in spring and of its acceleration in the autumn was made by van den Dungen, Cox and van Miegham[3], who used observations of the barometric pressure over the surface of the earth at different seasons. They showed that the effect could be accounted for in part by changes in the earth's moment of inertia due to seasonal changes in the distribution of air masses, but owing to incomplete data further investigation is required.

It may be pointed out that Chapter 5 of "The Atmospheres of the Earth and Planets", edited by Prof. G. P. Kuiper, deals with the work of Whipple, Jacchia and Kopal on seasonal changes in the upper regions of the atmosphere. The whole upper atmosphere at a height of about 78 km. appears to rise in spring by 8 or 9 km. and to drop again by the same amount in the autumn. No reference is made in Finch's paper to this phenomenon, which may have to be taken into account in future explanations of the seasonal changes in the earth's rate of rotation. The fluctuation of approximately annual period in the mean longitude of the moon, deduced from occultation observations, is much too large to be explained by the variations in the rotation of the earth.

[1] *Mon. Not. Roy. Astro. Soc.*, **110**, 1 (1950).
[2] *C.R. Acad., Paris*, **203**, 39 (1936); **205**, 79 (1937).
[3] *Bul. Cl. Sci. Acad. roy. Belgique*, **5**, Series 35 (1949).

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# PACIFIC SCIENCE BOARD

## ANNUAL REPORT FOR 1949

THE third annual report of the Pacific Science Board, covering the year 1949*, reviews briefly the work of the Seventh Pacific Science Congress, which was convened at Auckland and Christchurch during February 2–22, 1949; the Congress was attended by representatives of twenty-four countries, and more than five hundred papers were presented. Plans are now well advanced for the publication of the proceedings of the Congress, and the present report lists some articles describing the work of the Congress in general or in specific fields.

The Co-ordinated Investigation of Micronesian Anthropology programme consisted largely of continuing work by the participants on their final reports, of which twenty-six have now been accepted by the Board. The titles of these are listed in the report of the Board, and the reports are expected to be published by the sponsoring institutions or in appropriate scientific journals. The proposal to appoint three anthropologists to the staffs of the civil administrators in the Palau, Truk and Marshall Islands could not be implemented in 1949; but five anthropologists are already used by the United States Navy in its Civil Administration Units in the Trust Territory. The programme was extended in March 1949 to include other fields of science and is known as Scientific Investigations in Micronesia. Ten participants were appointed to carry out field work in the Trust Territory in anthropology, linguistics, botany and zoology.

The Insect Control Committee for Micronesia has sponsored a detailed study of *Achatina fulica* in various islands in the Trust Territory with the view of determining the variation in populations, extent of damage to crops, local predators, etc., and has sent a technician to investigate the possibility of processing it for human or animal food. Reports have been received that the wasp, *Scolia ruficornis*, that preys on the rhinoceros beetle (*Oryctes rhinoceros*) has become well established in western Samoa. Under the Conservation Committee for Micronesia, problems of the trochus shell (*Trochus niloticus*) fishery and of the robber or coconut crab (*Birgus latro*) have been investigated, as well as the damage to water supply and agricultural land resulting from mining operations on Angaur in the Palaus.

As a result of a report by Dr. C. J. Fish with Mary C. Cobb on "Noxious Marine Animals of the Central and Western Pacific", the Pacific Science Board has been requested by the United States Office of Naval Research to consider the preparation of a handbook that could be used by those stationed in the area on poisonous and otherwise dangerous animals in the Central and Western Pacific. Prospects for the realization of the high purpose of furthering scientific research in the Pacific through the agency of the Pacific War Memorial, which was established as a scientific foundation dedicated as a living memorial to those who served with the Armed Forces of the United States in the Pacific, depend on the availability of substantial support which has not yet materialized. Details of the Fulbright programme are included in the report, as well as a summary of the initial programme of the South Pacific Research Council for 1949–50.

Field projects approved by the Board include a Pilot Nutrition Study in Micronesia, with special reference to children, a mid-Pacific oceanographic project, a serological survey of the Pacific area, an anthropological and ethnographical study of the Southern Rynkyn Islands, a botanical study of New Caledonia, a filariasis survey of Tahiti, a study of diabetes mellitus in Guam, an anthropological and archæological survey of Saipan and an ethnological study of the Gilbert and Ellice Islands. Substantial progress is being made through the co-operation of the United Nations Social and Economic Council and its specialized agencies in awakening countries of the Pacific Area to the urgent need for taking measures to conserve their renewable natural resources. During the year the executive secretary of the Pacific Science Board visited the French Institute of Oceania, at Noumea, which it is hoped will increasingly become a base for international co-operative research in various fields of science.

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* Pacific Science Board. Third Annual Report, 1949. Pp. 154. (Washington, D.C.: National Research Council, 1950.)

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications*

## Photo-electric Measurements of the Density of Tracks in Nuclear Emulsions

GRAIN-COUNTING is an important method for the study of charged particles in photographic emulsions The method is well suited for the Ilford *C* 2 emulsion and others of a similar kind, but does not work for heavily ionizing particles in electron-sensitive emulsions, for example, the Ilford *G* 5 We have measured the density of the tracks in such cases by a photo-electric method

A slit was mounted in the eyepiece of a microscope and the divergent light passing through the slit was allowed to fall on the cathode of a photo-multiplier tube (*RCA* 1 *P* 21) A portion of the track was adjusted symmetrically in the slit and the resulting photo current measured in terms of the current without track Figs 1 and 2 give the results of such measurements for 55 tracks from *G* 5 plates exposed during a balloon flight to an approximate altitude of 20 km The length of the slit corresponds to 30 μ of track-length

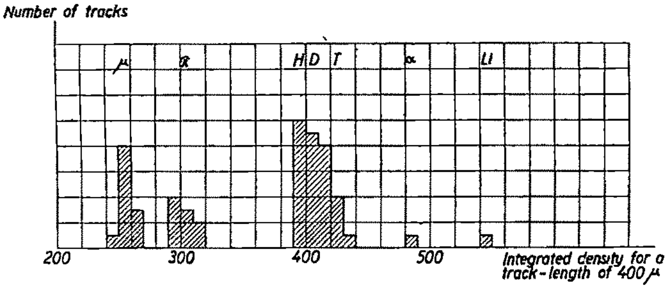

Fig 1 Histogram of integrated densities for a track-length of 400 μ of 55 tracks in Ilford *G* 5 emulsion

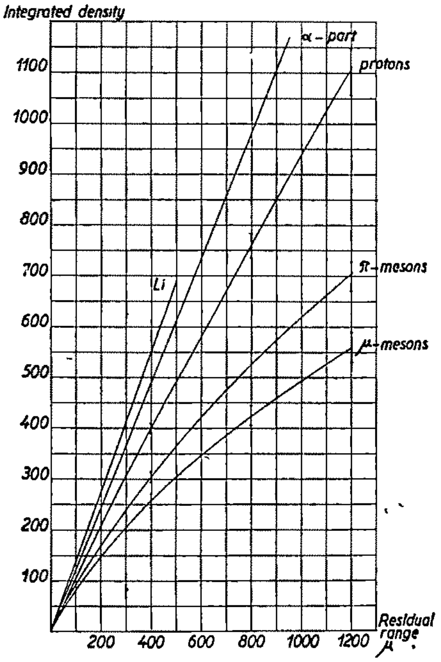

Fig 2. Integrated density in arbitrary units against residual range for tracks in Ilford *G* 5 emulsion

The diagrams show that it is possible to distinguish with certainty between π- and μ-mesons The limits of error indicated in the diagrams cover all measured values The method is also well suited for tracks from heavy particles

A detailed account of the method and of results obtained will be given elsewhere

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KRISTER KRISTIANSSON

Physics Department,
University of Lund
June 16

## Production of Uniform Droplets

A SIMPLE apparatus has been evolved which will generate lines, or streams, of droplets All those in one stream are of the same size and follow the same trajectory, but differ from those in another stream Primary and subsidiary droplets are formed, and, by adjustment, diameters ranging from 10 μ to 300 μ may be obtained The production of the droplet system is regular, and may be watched in slow motion if illuminated by a stroboscopic light source

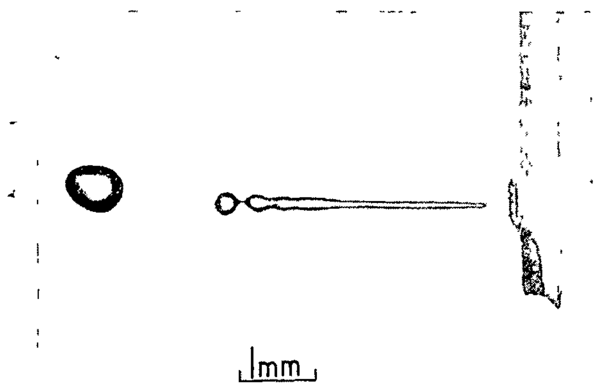
The basis of the apparatus is a vibrating hollow reed supplied with liquid A length of ordinary glass tubing 3/16 in or ¼ in outside diameter is drawn to a fine capillary of about 0·025 in outside diameter and up to 8 in long On to this reed is waxed a short piece of 1 or 1·5 mm steel hypodermic tubing an inch or two from the shoulder, to act as an armature A mounting is now necessary to clamp the butt of the capillary firmly and to support a small electromagnet, aligned with the armature, and energized by an alternating current The mains supply via a transformer is suitable for this

With liquid supplied to the butt of the hollow reed (only a small head is needed), and the electromagnet switched on, the capillary is tuned to resonance with the applied frequency by shortening it in steps of about 1/16 in The tip of the reed will then sweep a path varying from a straight line to a circle depending apparently on the cross-sectional form of the capillary and its alignment with the magnet Thus by arranging for the position of the magnet to be adjustable, and by twisting the reed in its clamp, a wide variation may be obtained

Streams of droplets are thrown off at various points on the path of the reed tip, usually at points of maximum acceleration

A cylinder provided with an aperture, and surrounding the vibrating tip, enables a single stream of drops to be selected The axis of the capillary may be at any angle provided the tip is below the butt

A series of photographs was taken over a period of 15 min showing the stages in the formation of one droplet system, and representing a continuous time of 3·3 sec $^{-3}$ Initially it was attempted to obtain pictures using the stroboscopic illumination only, but the long exposures made necessary by the low-power neon lamp did not give perfectly clear results (A 10-sec exposure means the superimposition of 1,000 droplets ) The final series of photographs, of which the accompanying illustration is one, was obtained using a 56-Joule, 1-microsecond flash tube The triggering of this tube, to coincide with desired stage



of droplet formation, as seen through a low-power telescope and illuminated by the strobo-torch, was achieved by synchronizing the trigger pulse with the grid signal to the strobo-torch, with a manual firing switch The illustration shows the primary drop, free and oscillating as it moves away from the capillary, with an unstable filament of water detached from the reed and about to divide into a secondary droplet and afterwards a number of subsidiary droplets

To enable the diameters of the droplets to be measured, they were caught in shallow fabricated dishes containing castor oil[1] or, for the smaller sizes, a mixture of paraffin oil and hydraulic fluid If they successfully penetrate and hang from the surface of the oil, their shape remains spherical, and they do not evaporate for an appreciable time

As one example of the use to which the apparatus could be put in the study of single droplet combustion, it was found possible, using kerosene in place of water and with the axis of the capillary horizontal, to ignite a stream of drops ascending nearly vertically Burning continued at the top of the trajectory over a distance of 1 5 in and was maintained by the arrival of fresh droplets

I believe that the uniformity of size in a single stream of drops from the apparatus outlined here is much greater than that obtained with a spinning-disk type sprayer, although it has the disadvantage of producing only a limited quantity

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this letter I also wish to record my thanks to A J Colbourn for his assistance in obtaining the photographic records

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June 20

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[1] *Engineering*, 159 (Jan 26, 1945)

## Adsorption of Insoluble Vapours on a Water Surface

Dr C L Cutting and one of us have completed an extensive series of measurements on this subject, and a paper embodying them is now pending publication Reference is there made to earlier work, especially that of Cassel and Formstecher[1] The Gibbs's equation is used in the form $\Gamma_2^{(1)} = \frac{p}{RT}\frac{\partial F}{\partial p}$, and the methods of Ferguson and Hakes[2] and of Sugden's[2] adaptation of the maximum pressure in bubbles method have been used to determine the $F$—$p$ curves, which have been followed up to a value of partial pressure close to saturation They have proved very suitable methods for a wide survey of the field

We have now, however, applied successfully the vertical film balance to this problem, which has enabled accurate measurements to be made on a static surface, the contact angle being zero The vertical film balance is incorporated into the apparatus shown in Fig 1 The water is contained in a trough $A$, which enables a clean surface to be formed by overflowing from $B$ (*vide* Harkins and Jordan[3]) The plate $D$ hangs in the trough, being suspended through a tube in the stopper $E$ from an analytical balance fitted with a mirror on the beam, so that deflexions can be measured by means of a lamp and scale Initially, the plate is hung in the clean surface and the balance adjusted to equilibrium The vapour of the adsorbate is passed at varying partial pressures over the surface through four nozzles, $G$, by carriage in a stream of air As the surface tension decreases the plate rises, and the surface pressure, $F$, can be calculated directly from the observed deflexions

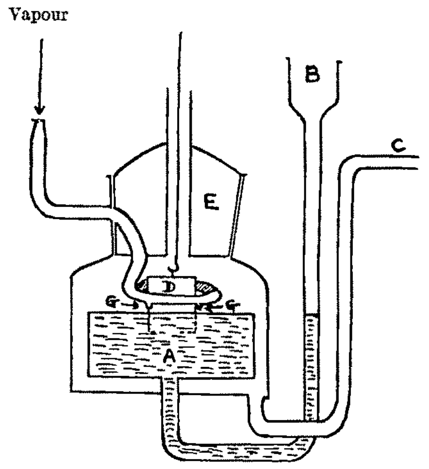

Fig 1

The reductions of tension are almost linear at low partial pressures in all cases, but increase progressively up to the saturation value As an illustration, in Fig 2 the calculated $\Gamma_2^{(1)}$ is plotted against the vapour pressure for the case of $n$-hexane on water at 0° C, 7 5° C and 15° C, and a clear picture is given of the rapidly increasing adsorption as the neighbourhood of saturation is approached The values of the adsorption at saturation may depend greatly on changes in surface tension, perhaps very small, occurring at partial pressures of vapour extremely close to saturation, and until we have examined this point more critically experimentally, we are uncertain that the values indicated in the graphs represent accurately the adsorption at, or very close to, saturation

If one assumes that the hydrocarbon molecule is lying flat and exposing its maximum surface to the water interface, then a monolayer value is approached at approximately 92 per cent of saturation, but above this value of partial pressure, the extent of adsorption rapidly increases to values of two to three times the monolayer value Much smaller values would be obtained, approaching a monolayer only, if it were assumed that, as saturation is approached, the molecules become oriented vertically, exposing an

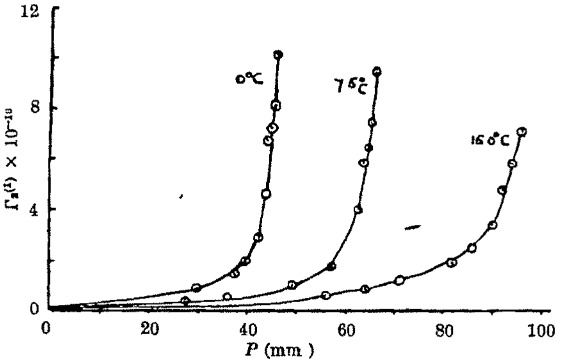

Fig 2

area to the surface of about 20 sq A It will be noted that the isotherms are convex to the pressure axis as is the case for the curves shown by Cassel and Formstecher, and for the adsorptions of all the insoluble vapours on a water surface investigated by Dr Cutting This is the rarely observed type III curve of Brunauer[4], and it is of interest that preliminary calculations show that the heats of adsorption are less than the heats of liquefaction, in agreement with Brunauer's views, which are similar to those of Langmuir[5], in whose paper the occurrence of multilayers receives quantitative consideration in Case VI However, the above form of the adsorption isotherm is not observed only in the case of multilayer formation, when certain relationships exist between the lives of the adsorbed molecules at the surface and in the subsequent layers, but would, as Cassel and Formstecher showed, be obtained also when the adsorption is less than a monolayer if the film were gaseous with the attractive correction preponderating

One of us (R H O ) is a holder of a maintenance allowance from the Department of Scientific and Industrial Research, and a Royal Society grant has partly defrayed the cost of the investigation

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D C JONES

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May 7

[1] Cassel and Formstecher, *Kolloid Z* , 61, 18 (1932)

[2] Ferguson and Hakes, *Proc Phys Soc* , 41, 414 (1929) Sugden, *J Chem Soc* , 27 (1924)

[3] Harkins and Jordan, *J Amer Chem Soc* , 52, 1751 (1930)

[4] Brunauer, "The Adsorption of Gases and Vapours", 150 (1945)

[5] Langmuir, *J Amer Chem Soc* , 1372 (1918)

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## Positive Point-to-Plane Spark Breakdown of Compressed Gases

THE increase of spark breakdown potential of gases with increase of pressure does not apply for all electrode configurations It has been shown[1-4] that an anomalous decrease occurs in the positive point-to-plane breakdown potential of some gases at several atmospheres pressure

An investigation of this effect using air, nitrogen (oxygen-free), 'Freon 12' and sulphur hexafluoride is being made in this Department Examples of spark breakdown voltage–pressure curves obtained for these gases are shown in the accompanying graph, together with details of the gap configuration It seems from these results that two conditions are necessary for the existence of this phenomenon (1) that a divergent field configuration, with the high-field region at the anode, be used, and (2) that spark-over occurs in a gas which forms negative ions In the case of positive point-to-plane spark-over in a gas mixture, only one electron-attaching gas is necessary, for example, compressed air[2,3] and commercial nitrogen[1] exhibit this effect, whereas nitrogen (oxygen-free) does not

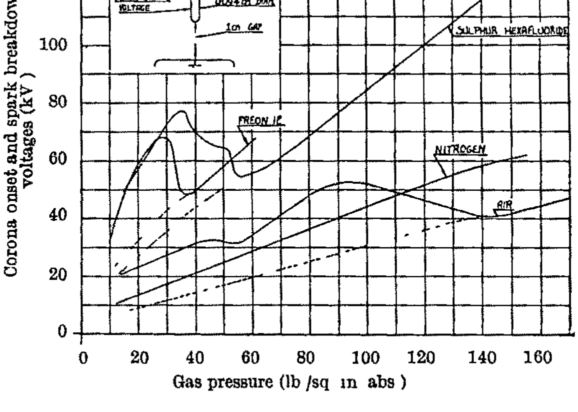
At pressures between the critical pressure, $P_c$ (where the corona onset curve coincides with the spark breakdown curve), and the pressure corresponding to the maximum breakdown voltage, $P_m$, the sparking paths are curved Howell[2] has reported on this, and photographs of curved sparks, taken from two mutually perpendicular directions, have been obtained here In electron-attaching gases at pressures below the critical pressure, a visible, fan-shaped corona at the anode precedes spark-over At pressures higher than $P_c$, sparking occurs without corona , no corona has been observed here in nitrogen (oxygen-free) at pressures higher than 30 lb per sq. in abs.

These phenomena may be tentatively explained by considering the effect of pressure increase on the mechanisms of positive streamer formation

The lateral spreading of electrons at the tip of a Townsend avalanche probably decreases with increase of pressure This causes increased field distortion by positive space-charge and, therefore, facilitates the production of photons by electron-positive ionic recombination[4] Increase of pressure also increases the absorption coefficients for these photons The chance of a streamer developing across the low-field regions of a point-to-plane gap is therefore increased

These considerations seem to explain the observed effects in nitrogen, where initial streamers caused breakdown Such self-sustaining streamers could also cause spark-over in electron-attaching gases at pressures higher than $P_c$

In electron-attaching gases at pressures lower than $P_c$, other mechanisms occur which reduce the field distortion of a primary avalanche and make it less likely for a streamer to cross the gap. Most important of these streamer-quenching mechanisms is probably the attachment of avalanche electrons, especially those at the rear of the advancing tip, forming relatively immobile negative ions This reduces the ionization and the yield of photons in an initial avalanche In certain gases, for example, $CCl_2F_2$, dissociation processes cause molecules with high electron affinities to be introduced in the avalanche path[5]



In electron-attaching gases at pressures lower than $P_c$, quenched streamers spread photo-electrically over the point to form a self-sustaining corona This corona effectively extends the point and makes the applied field less divergent

The positive ions created in the corona constitute a mid-gap space-charge which further distorts the field At pressures below $P_m$, it is assumed that this space charge does not reduce the field at the face of the corona sufficiently to prevent axial breakdown streamers At $P_m$ reduced diffusion of positive ions is assumed to increase space-charge distortion so much that breakdown streamers are forced to take curved paths

Since the curved sparks follow fairly low-field paths, the condition of axial breakdown is being approached Increase of pressure beyond $P_m$, therefore, enables curved streamers to develop with less field distortion The spark breakdown-voltage and corona current at spark-over would be expected to decrease at pressures above $P_m$ [2] This decrease of spark breakdown-voltage and breakdown corona-current will continue until pre-onset streamers initiate axial breakdown of the gap with field distortion due to corona space charge at zero

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June 19

[1] Goldman, I, and Wul, B, *Tech Phys U S S R*, 1, 497 (1935), 3, 16 (1936)

[2] Howell, A, *Trans Amer Inst Elect Eng*, 58, 193 (1939)

[3] Pollock, H C, and Cooper, F S, *Phys Rev*, 56, 170 (1939)

[4] Hopwood, W, *Proc Phys Soc*, 62B, 657 (1949)

[5] Warren, J W, Hopwood, W, and Craggs, J D, *Proc Phys Soc*, 63B, 180 (1950)

## Energy in Electrostatics

DIFFICULTIES encountered by Stoner[1,2] and Guggenheim[3-5] in their attempts to apply thermodynamics to systems which contain magnetizable matter have made these writers aware of important defects in the usual development of the notion of energy in the theory of magnetism and in the analogous theory of electrostatics The difficulties occur at the outset, when it is desired to write a general equation to express the first law of thermodynamics, such an equation must allow for density change in the material substance of the system and must include a term to allow for variation of magnetic energy It is then essential to express this latter variation in a form which is valid when the material bodies in the system are deformable Stoner and Guggenheim have not done this, and, besides, their discussion excludes systems in which hysteresis can occur. In the remarks which follow I refer to the analogous electrostatic problem

The objection insisted upon by Guggenheim to the available accounts of electrostatics is that the theory is constructed with the particular relation $\mathbf{D} = K\mathbf{E}$ especially in mind, and that in consequence these accounts fail to establish notions and formulæ of general validity In the case of energy and the formulæ pertaining thereto, there is serious confusion and error With this criticism I am in complete agreement, I believe that no thoroughly satisfactory account of the energy in electrostatic systems has been presented anywhere The peculiar difficulties of a general theory appear to have been recognized by De Donder[6], who writes "Quand on étudie l'énergie électrique localisée dans un champ électrique dû à des volumes polarisés, il se présente une réelle difficulté, nous la surmontons en nous plaçant respectivement au point de vue *microscopique* et au point de vue *macroscopique*".

Guggenheim has re-examined the notion of energy in electrostatics and derives a work formula which he claims to be of general application Thus he writes concerning an electrostatic system which contains dielectrics, "for an infinitesimal change in the system either of an electric charge, or a conductor, or a dielectric, the electric work done on the system is given by

$$w = \int dV\, \mathbf{E}\, d\mathbf{D}\text{''} \qquad (1)$$

This is a mistake

A crucial point[7] which has not been noted explicitly before is that the general electrostatic system containing dielectrics is *not mechanically conservative* That is to say, there is no function depending only upon the position of the charges and the configuration of the dielectric bodies in the system whose decrement for a displacement of the system is equal to the work done by the mechanical forces in the system It is only by a detailed and formal development of the theory of dielectrics *ab initio* that this assertion can be fully substantiated I remark simply but emphatically that there is profound confusion in the literature between the notion of energy as a physical entity and the notion of energy as a mechanical potential energy function

Consider a common statement that the electrostatic energy of a system is

$$\tfrac{1}{2}\int \mathbf{E.D}\, dv \qquad (2)$$

This is meant to imply that the function (2) is a mechanical potential energy function for the system It will be so, subject to two essential provisos first, that the vectors **E** and **D** should be linearly related, and secondly, that the dielectric bodies in the system should be undeformed Guggenheim insists upon the necessity of the first condition, and so his work formula (1) has been derived to apply when **E** and **D** are not linearly related However, he has failed to recognize the second condition, and consequently (1) is invalid unless this restriction is stated Guggenheim's statement quoted above is thus false specifically because it permits a movement or deformation of the dielectric bodies present in the system

It is easy to modify (1) so as to make it apply generally Consider an electrostatic system which consists of a distribution of charge with density $\rho$ in a volume $v_1$ and a dielectric body occupying a volume $v_2$ If $\delta W$ is the work done by the mechanical forces in the system during an infinitesimal movement of the system, write (1) in the form

$$\delta W = -\int \mathbf{E}\,\delta\mathbf{D}\, dv = -\int \mathbf{E.}\delta\mathbf{E}\, dv - \int \mathbf{E.}\delta\mathbf{P}\, dv,$$

where **P** is the polarization This formula holds, provided the dielectrics in the system are undeformed However, if the relation is rewritten as

$$\delta W = -\int \mathbf{E}\,\delta\mathbf{E}\, dv - \int \mathbf{E}\,\delta(\mathbf{P}\, dv), \qquad (3)$$

it is true generally

I have discussed elsewhere[7] the method of Helmholtz for deriving the mechanical force acting in a dielectric This method involves deforming the dielectric and calculating the work done by the mechanical forces acting in the system from the energy function (2) when **E** and **D** are linearly related or by use of the formula (1) in the general case Strange and elaborate expressions for the force acting on the dielectric are obtained[8] Larmor and Livens reject the Helmholtz method and the results obtained by its means, and propose instead an elementary formula for the force acting on the dielectric derived directly from the notion of a polarized medium I have shown that the deformation method leads to the formula of Larmor and Livens provided the work done in the deformation is calculated from (3) instead of from (1) or (2)

Finally, I have shown[7] for the case of a fluid dielectric how to derive the equation sought by Stoner and Guggenheim to express the first law of thermodynamics The method has since been extended to obtain the corresponding equation for solids

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June 19

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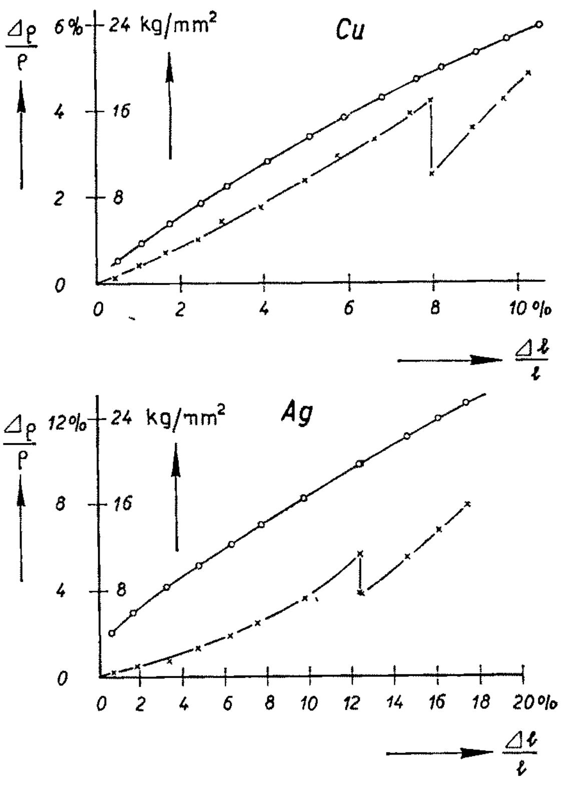
## Change of Resistivity by Cold Working at Liquid-Air Temperature

THE relative change of resistivity ($\Delta\rho/\rho$) with plastic deformation at liquid-air temperature has been measured on several materials Wires of copper, silver and aluminium which had been soft-annealed were stretched The tension producing the extension as well as the resistivity were measured The tension was removed after extension, and the resistivity was measured when there was no stress on the wire The tension was then applied and increased so as to produce further plastic deformation At an extension of approximately 10 per cent, the wire was removed from the liquid air and allowed to warm up to room temperature or heated to a higher temperature The wire was then again placed in liquid air and the resistivity measured The tension required to produce further plastic deformation was then determined as well as the resulting change of resistivity $\Delta\rho/\rho$

It can be seen from the accompanying graphs that there is a discontinuity in the $\Delta\rho/\rho$ versus $\Delta l/l$ curve at the point where the temperature of the specimen was increased for a short while There is no corresponding discontinuity in the tension versus $\Delta l/l$ curve The minimum time for which the specimen was kept at room temperature was 10 min No further decrease in $\Delta\rho/\rho$ was observed if the specimen was kept at room temperature for longer periods (up to 18 hr)

For aluminium the relative decrease in $\Delta\rho/\rho$ was considerably larger than for copper or silver The effect of keeping the specimen at higher temperatures up to 150° C was investigated for copper and silver No further decrease in $\Delta\rho/\rho$ was observed

As the curves of tension versus $\Delta l/l$ are continuous, whereas there are discontinuities in the $\Delta\rho/\rho$ versus $\Delta l/l$ curves, the experiments show that the mechanism producing hardening by cold work is at least in part different from that producing the change of resistivity This might explain the discrepancy between the observed values of $\Delta\rho/\rho$ and those calculated from the work done in producing dislocations[1]



*Above* Copper drawn at −183° C to 8 per cent extension, allowed to warm up to 20° C and kept there for 3 hr, then drawn further at −183° C to an extension of 11 per cent
*Below* Silver drawn at −183° C to 12 per cent extension, heated to 140° C and kept there for 10 min, then drawn further at −183° C to an extension of 17 per cent
x—x, $\Delta\rho/\rho$ versus $\Delta l/l$, o—o, tension versus $\Delta l/l$

The magnitude of $\Delta\rho/\rho$ depends to a very great extent on the annealing temperature, slightly different heat treatments changing $\Delta\rho/\rho$ by a factor of 2 The previous history of the specimen may also be important The discontinuity in the $\Delta\rho/\rho$ versus $\Delta l/l$ curve, however, always occurred

The investigation is being continued These measurements were made under the direction of Prof M J Druyvesteyn (Delft), to whom we express our thanks One of us (W H A) also wishes to thank the South African Council of Scientific and Industrial Research for a research grant which made it possible for him to attend the Technische Hogeschool, Delft

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Dutch State Mines, Heerlen

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[1] Sondheimer and Mackenzie, *Phys Rev*, **77**, 264 (1950)

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## Absorption Spectrum of Tin Vapour in the Schumann Region

As part of a programme of studies of absorption spectra of vapours of metallic elements in the far ultra-violet[1], exploratory observations have now been made for tin, with the results here described

The Sn I emission spectrum has been subjected to careful study by Meggers[2], who made new observations from λ1,697 to the end of the photographic infra-red, and also embodied bolometer measurements made by other observers in the photographically inaccessible region All terms and transitions classified by him belong to the series spectrum, involving excitation of one of the $5p$ electrons from the $5s^2\ 5p^2$ ground-configuration, though he surmises that a pair of superfluous levels found may be part of the $5s\ 5p^3$ configuration Some of the terms of the latter are likely to lie above the first ionization potential of tin (7 3 volts), and it is expected that combinations with these will show up better in absorption

With an arrangement similar to that used in the cases of indium and gallium[1], the absorption spectrum of tin vapour has been photographed in the range 1,100–2,300 A

At a furnace temperature of 1,600° C, many absorption lines were obtained, all, or nearly all, of which are believed to belong to tin and not to impurities Of twenty-one lines in the 1,600–1,800 A range, seventeen are new The remaining four, namely, λλ 1,793 4, 1,753 3, 1,729 2, 1,714 1, were observed in emission by Meggers, but are unclassified, these four lines are thus shown to be combinations with the ground-term $5^3P$ Many of the lines of this group are diffuse, and a few of considerable breadth (10–20 A ) In the range 1,300–1,400 A there occurs a strong triplet exhibiting the intervals of the ground-term

At 1,800° C the broader lines in the 1,600–1,800 A range become so wide as to obliterate intervening structure At this temperature also, all the stronger combinations with the ground-term listed by Meggers above 1,800 A are present in absorption

For these initial exposures, fast coarse-grained plates were used, and the complication of impressing good wave-length standards was avoided In order to make as complete an analysis as possible, improvements in these respects are in hand For the present, occurrence of the ground-term intervals in the rather rough measurements possible enables the placing of three new levels, each having $J = 1$, at the following positions with respect to Sn II $5s^2\ 5p\ {}^2P_{1/2}{}^0$

| Level | cm$^{-1}$ above Sn II $5^2P_{1/2}{}^0$ |
|---|---|
| $A$ | 16,797 ± 10 |
| $B$ | 2,611 ± 5 |
| $C$ | 1,246 ± 5 |

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## 'Sudden Commencements' in Geomagnetism

'Sudden commencements' which appear in magnetogram traces have been recognized in the past more or less by their similarity to accepted typical movements, and the 'normal' s c has been subdivided into two types according as the main movement is preceded by a smaller movement in the opposite direction or not In the paper on 'sudden commencements' by H W Newton[1] in 1948, the second type was regarded as one showing the preliminary movement in all three traces, though in the later analysis it was shown that the initial movement or 'tail' might take place in one element only, such as $H$ or $D$ The frequency in which the tail movement was observable in $D$ and not in $H$ was slightly greater than *vice versa*

A recent note by Ferraro and Parkinson[2] has suggested that the frequency of occurrence of type II s c 's may be a function of geomagnetic longitude, being a minimum at the longitude of Honolulu and a maximum at that of Greenwich or Abinger In the note the types of s c are defined only in relation to the horizontal force $H$ This is, of course, possible, since the definition is to some extent arbitrary, but it leaves out the cases in which the preliminary movement is apparent in $D$, though not in $H$ With this definition, the ratio of type II s c 's to all s c 's for Greenwich as derived from Newton's paper would read 0 42 instead of 0 55 It would still leave the Greenwich point high on the graph, however

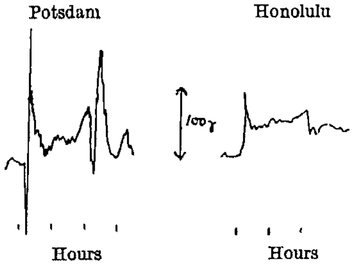

Fig 1 Sudden commencement, May 13, 1921

As a rough test of the validity of the graph, the corresponding frequency of s c 's showing the preliminary movement in $H$ only was computed for Sitka (geomagnetic longitude 275°) Published copies of the magnetograms for that station were available for the three years 1946–48 by courtesy of the U S Department of Commerce, Coast and Geodetic Survey The result showed a frequency of type II s c 's comparable with Abinger, though the longitude would indicate from the graph a minimum similar to Honolulu Too great weight cannot be placed on this result, obtained from only three years magnetograms, and Sitka may be an anomalous station Some further evidence, though again for a very short period of time, was available from the *Journal of Geophysical Research*, s c 's for 1949 being classified as above Hermanus, longitude 80°, showed a very small proportion of type II s c 's, while College, Apia and Amberley, with longitudes all near that of Honolulu, gave high proportions, of the same order as Abinger

A feature which would be expected from low-latitude stations like Honolulu and Tucson is the marked reduction in the amplitude of oscillations observed in the trace during storminess This is illustrated by the traces at Potsdam and Honolulu during the first few hours of the great storm of May 13, 1921 (Fig 1), which show also the very gradual build-up of the s c

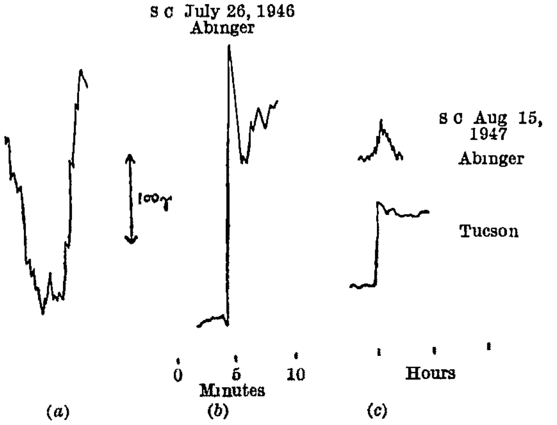

Fig 2

at Honolulu. One possibility is that the 'tail' effect in s c 's may be connected with such oscillations, as movements found during storm periods bear strong resemblance, superficially at least, to s c types (Fig 2*a*) At times, too, the s c cannot be separated from the subsequent oscillations of the storm (Fig 2*b*), merging imperceptibly into them, while at others a normal s c at one station may appear as a succession of strokes or oscillations at another (Fig 2*c*). If the serrated nature of the magnetogram traces during storms is due to superimposed oscillations, the presence of the 'tail' may also be explained in this way One would then expect dependence on geomagnetic latitude in their occurrence, as the oscillations increase with latitude, but the evidence from stations like Apia and Hermanus would scarcely support this A possibility is that the absence of the preliminary movement at some stations may be due to damping caused by induced ionospheric currents , the differing rates of change with time of the main stroke when s c 's at several stations are compared would suggest such damping But evidence from a number of widespread stations would be necessary to establish such effects

This note is communicated by courtesy of the Astronomer Royal.

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## Role of the Thyroid in Sexual Development in the Male

CONSIDERABLE work has been done in the field of thyroid physiology , but the role of the thyroid in male fertility needs further clarification, since extremely variable results have been observed, due, it is believed, to species and breed differences, age and stage of sexual development, dose and duration of the hormone administration, plane of nutrition and environmental temperature With the previous work in view, an attempt has been made to study the effects of known levels of thyroid stimulation and inhibition, under natural environmental conditions, upon the gonads, that is, on spermatogenesis, the development and secretory activity of the interstitial cells, accessory male organs, sex behaviour and semen evaluation of the growing male rabbit and the ram at various stages of sexual development

In a series of experiments, it was observed that mild hyperthyroidism within the physiological range stimulated spermatogenesis and increased the secretory activities of the interstitial cells of the testis as judged by the growth and functional activities of the accessory male organs and the sex behaviour in growing male mice[1], buck rabbits and rams On the other hand, thyroidectomy or prolonged thiouracil-treatment interfered with the normal process of spermatogenesis , the seminiferous tubules showed atrophic and degenerative changes, the spermatogonial cells being disorganised and the tubules appearing to contain an abnormal accumulation of cells The Leydig cells showed greater abnormal appearances, and the normal interstitial spaces showed an increase in the fibrous tissue but with reduced cellular elements Mild hyperthyroidism resulted in precocious sexual development in the young male rabbit and the ram, while prolonged hypothyroidism or severe hyperthyroidism interfered with the normal reproductive processes

Thyroxine-treatment at the above levels greatly improved the sexual libido and sex drive in the buck rabbit, ram and boar, which previously had shown lessened sexual libido and poor sex drive Thyroidal stimulation during the non-breeding season prevented to a great extent the seasonal variations in sexual desire and quality of semen in the young ram There was a considerable improvement in the semen of the treated buck and the ram Continued administration of larger doses of thiouracil to the growing male markedly impaired the sex behaviour and the semen was of very poor quality The degree of impairment of these functions depended upon the age of the treated male, dose and duration of treatment and the environmental conditions

The mechanism whereby the thyroid influences gonadal functions probably involves a complex series of interactions The depression of sexual development during hypothyroidism may be due, in part, to reduced secretion of the pituitary gonadotrophins, while the increased functional activities of the testes and accessory male organs of young mice[1], the buck and the ram, observed in mild hyperthyroidism, is probably due to the increased output of hypophyseal gonadotrophic hormones which in the presence of thyroxine are responsible for the growth of the male sex organs The follicular stimulating hormone stimulates the growth of the seminiferous tubules, and the increased production of luteinizing hormone stimulates the secretion of the male sex hormone by the Leydig cells of the testes The increased output of the male sex hormone in turn is responsible for the growth and functional activities of the accessory male organs and sexual behaviour Further, the thyroid hormone may also facilitate the utilization of hypophyseal gonadotrophic and gonadal hormones by the organism due to its metabolic conditioning of the cells involved

I am indebted to Dr J Hammond and Dr A Walton for their help and to Mr A G Carruthers for statistical analyses of the results

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## Effect of Acetoacetic Acid on Reduced Glutathione Content of Blood in Rabbits

Nath and Brahmachari[1] have shown the hyperglycæmic effect of injections of sodium acetoacetate in rabbits Lazarow[2] has attempted to correlate the diabetogenic action of some chemical compounds with their ability to lower the reduced glutathione content of the blood With the view of finding whether acetoacetic acid influences the reduced glutathione content of blood, some experiments were conducted on rabbits The number of animals used was ten

It was found that the repeated injection of small doses gradually increasing from 25 to 75 mgm /kgm of body-weight of sodium acetoacetate to rabbits lowered the reduced glutathione content of their blood on an average by 40–50 per cent in twenty days

The effect of single massive subcutaneous injection of sodium acetoacetate was also studied The doses employed were 100, 200 and 300 mgm /kgm. of body-weight Two animals were used for each dose It was found that, depending on the dose, the reduced glutathione content of the blood was reduced by 30–66 per cent A second subsequent massive injection to the same animals on the next day resulted in lowering the reduced glutathione content still further

Gregory and others[3] have found that the injection of anterior pituitary preparations lowers the glutathione content of tissues Recently, Conn[4] has shown that there is a direct correlation between the production of a transitory diabetes in man produced by injecting a purified adrenocorticotrophic hormone, and the blood-glutathione level Leech and Bailey[5] have investigated the effect of alloxan, and they found that the blood-glutathione content may fall to near zero values on alloxan injection In view of these findings and the results reported here, it may be suggested that the lowering of reduced glutathione content of the blood is in some way responsible for the onset of diabetic troubles and *vice versa*, thus substances causing such reduction of reduced glutathione may increase susceptibility to the development of diabetes

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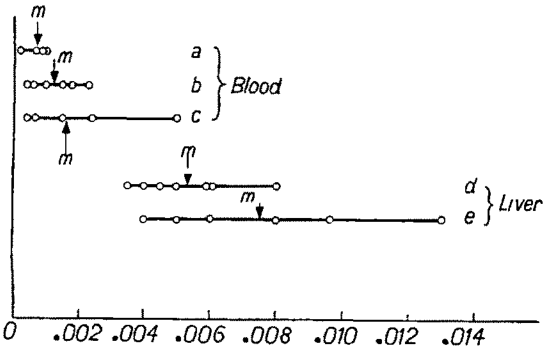
## A Possible Correlation Between the Zinc Content of Liver and Blood and the Cancer Problem

IN biochemical literature various metals are considered to be related to proteins present in the human body These metals can be regarded as 'tracers' for these proteins It was thought worth while to try to estimate these proteins by analysing ash of tissues and body liquids by means of the spectrograph for these metals The direct-current carbon arc gives satisfactory results

Among the elements iron, aluminium, calcium, sodium, potassium, magnesium, phosphorus, copper, zinc, lead, manganese, chromium, molybdenum, silver and silicon, determined during preliminary experiments, it was found that in the case of malignant growth the range of the zinc content was extended Although differences of mean values found are not particularly significant (see table and graph), it seems of vital importance to investigate on one hand the behaviour of zinc-containing proteins in the human body, and on the other hand the relation between zinc and malignant growth



Ranges of zinc concentration found in blood and liver of *a*, people with no disease (blood), *b*, patients with non-tumorous disease (blood), *c*, patients with malignant growth (blood), *d*, patients with non-tumorous disease (liver), *e*, patients with neoplasms (liver), *m*, mean values for zinc found

Mean values and standard deviations of zinc concentrations found in various samples of blood and liver

| Series | | *n*† | Mean per cent | Stand dev | Stand dev of mean |
|---|---|---|---|---|---|
| Blood | *a* (no disease)* | 6 | 0 0007 | 0 00026 | 0 0001 |
| | *b* (non-tumorous disease) | 7 | 0 0012 | 0 00062 | 0 0002 |
| | *c* (malignant growth) | 7 | 0 0016 | 0 0015 | 0 0006 |
| Liver | *d* (non-tumorous disease) | 7 | 0 0053 | 0 0014 | 0 0005 |
| | *e* (patients with neoplasms) | 6 | 0 0075 | 0 0030 | 0 0012 |

* Cf Vallee's value, found by using an improved dithizone method, mean 0 00083 per cent, stand dev of mean 0 00020 per cent (Vallee, B L, and Gibson, J G, *J Biol Chem*, **176**, 445, 1948)
† *n* = number of measurements

Various samples of material have been obtained from Dr P Nieuwenhuyse, professor of pathology in the University of Utrecht, who controlled all tissues, blood, etc, by histological and anatomical investigation

Results will be published in full in *Rec Trav Chim Pays-Bas*

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## Dextrorotatory Acids of Tubercle Bacilli Lipids

WE wish to report that the dextrorotatory acids of the lipids of human tubercle bacilli, hitherto believed to be saturated acids, are αβ-unsaturated acids

In a previous communication[1], one of us has described the isolation of three dextrorotatory acids This was effected by the fractional crystallization of semicarbazones and 2 4-dinitrophenylsemicarbazones of the acetol esters derived from the parent acids Two of these acids ($C_{28}$ and $C_{30}$) were solids and one ($C_{26}$) was a liquid It has now been found that the solid acids are readily separable from other constituents of the mixture, owing to the sparing solubility of their potassium salts in cold ether The analyses already given[1] included somewhat low figures for hydrogen (calculated for the saturated acids), and the theory for the new formulæ with two hydrogens less is in better agreement with the results

The experimental evidence for the αβ-unsaturation of these acids may be summarized as follows

The solid acids[1] ($C_{28}H_{54}O_2$, $[\alpha]_D^{20°}$ + 11 7° and $C_{30}H_{58}O_2$, $[\alpha]_D^{20°}$ + 4 8°) (all rotatory powers were taken in ether, *c*, 10–15) exhibited in purified cyclohexane $\lambda_{max}$ 220 mμ (log $\varepsilon_{max}$ 3 9) and $\lambda_{max}$ 219 mμ (log $\varepsilon_{max}$ 3 9), respectively, the liquid acid[1] ($[\alpha]_D^{20°}$ + 11 1°) gave $\lambda_{max}$ 220 mμ (log $\varepsilon_{max}$ 3 9)

A mixture of the solid acids (from the sparingly soluble potassium salts, found C, 78 8, H, 12 5, $C_{28}H_{54}O_2$ requires C, 79 6, H, 12 8 per cent $C_{30}H_{58}O_2$ requires C, 80 0, H, 12 9 per cent) exhibiting $[\alpha]_D^{20^\circ} + 7\ 9^\circ$, $n_D^{36^\circ}$ 1 4600, $\lambda_{max}$ 220 mμ (log $\varepsilon_{max}$ 3 9) gave, on hydrogenation in acetic acid in the presence of platinic oxide at 2 atmospheres pressure, a solid with $[\alpha]_D^{20^\circ} + 1\ 1^\circ$, $n_D^{36^\circ}$ 1 4516 (found C, 78 9 , H, 13 3 , $C_{28}H_{56}O_2$ requires C, 79 2 , H, 13 2 per cent $C_{30}H_{60}O_2$ requires C, 79 7 , H, 13 3 per cent) The liquid acid (from the easily soluble potassium salts), having $[\alpha]_D^{16^\circ} + 10\ 3^\circ$, $n_D^{36^\circ}$ 1 4655, $\lambda_{max}$ 220 mμ (log $\varepsilon_{max}$ 4 0) (found C, 79 2 , H, 12 8 , $C_{26}H_{50}O_2$ requires C, 79 2 , H, 12 7 per cent), on hydrogenation yielded an oil, $[\alpha]_D^{18^\circ} + 1\ 7^\circ$, $n_D^{36^\circ}$ 1 4563 (found C, 79 2 , H, 13 2 , $C_{26}H_{52}O_2$ requires C, 78 8 , H, 13 1 per cent) The marked decrease in rotation observed on hydrogenation of the unsaturated acids indicates that a centre of asymmetry resides near to the double bond

All the foregoing hydrogenated acids exhibited no measurable absorption in the ultra-violet

Examination of the infra-red spectra of the solid and liquid acids indicated the presence of a double bond in conjugation with the carboxyl group, whereas the hydrogenated products showed the absence of unsaturation

The mixture of the hydrogenated solid acids was subjected to a stepwise degradation It was converted to the α-bromo-acid and thence to the α-hydroxy-acid , the latter on oxidation with lead tetra-acetate afforded a ketone which formed a semicarbazone, m p 64–65°, after recrystallization from alcohol (found N, 8 2 , $C_{30}H_{61}ON_3$ requires N, 8 8 per cent) The formation of this ketone indicates the presence of a substituent in the α-position to the carboxyl group in at least one of the constituents of the mixture

Ozonization of the solid acids yielded as the main product an acid, $[\alpha]_D^{20^\circ} + 2\ 4^\circ$, $n_D^{38^\circ}$ 1 4528, of molecular weight comparable with the starting point Oxidation with potassium permanganate in acetone appears to yield the same acid Examination of the ultra-violet and infra-red spectra showed the absence of unsaturation and of carbonyl groups It was significant that acetic acid (about 70 per cent yield) but no oxalic acid was found among the ozonization products

Full experimental details will be published later and the investigation is being actively pursued , in some aspects in collaboration with Sir Robert Robinson

Anderson and associates[2] have isolated 'phthioic acid' ($[\alpha]_D + 12\ 56^\circ$) from human tubercle bacilli lipids Their procedure involved hydrogenation of the crude mixture of acids, and they erroneously assumed from the iodine values of the original mixtures that 'phthioic acid' is saturated prior to hydrogenation The acids isolated by us showed practically zero iodine value, but this involves no anomaly since αβ-unsaturated acids are known to be unreactive to halogens or equivalent reagents The rotatory powers of all three dextrorotatory acids are markedly decreased on hydrogenation, and hence we conclude that the hydrogenation carried out by Anderson and Spielman[2] was incomplete It is highly improbable that 'phthioic acid' is homogeneous, and the evidence (especially from C-methyl determinations) accords best with the view that it was substantially derived from the $C_{26}$ acid (above) by partial hydrogenation

We are indebted to Glaxo Laboratories, Ltd , for the provision of extracts of tubercle bacilli, to Dr F B Strauss for the ultra-violet spectra, and to Dr L N Short for the infra-red spectra The work of one of us (J D C ) has been facilitated by grants from the Rockefeller Foundation and the Dazian Foundation, New York

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## Fibrin Clots

Two kinds of fibrin have recently been distinguished by the test of whether or not they could be dissolved in 30 per cent urea[1,2] Normal physiological plasma-clot is insoluble in urea, whereas the clot obtained by the action of purified thrombin on purified fibrinogen dissolves easily It has further been established that both a thermolabile component of the serum and calcium ions are needed to form a urea-insoluble clot from the purified fibrinogen–thrombin system The internal network structure of the two sorts of clot must be different in some way , and since urea-soluble fibrin can also be dispersed by certain solvents which are known to break hydrogen bonds, for example, guanidine and monochloracetic acid, it would appear that this type of network is held together by secondary forces only In plasma-clot, however, the particle association seems to be reinforced by stronger linkages

X-ray studies also reveal a difference between urea-soluble fibrin and plasma fibrin Fibres of the latter stretch readily from the α- to the β-configuration (in fact, it is difficult to prepare well-oriented α-specimens without producing some β[3]), but greater extensions are required with urea-soluble fibrin[4] The internal cohesion of plasma fibrin is therefore higher than that of urea-soluble fibrin, possibly by virtue of added cross-linkages As judged by the X-ray test, urea-soluble fibrin has an internal cohesion intermediate between plasma fibrin and fibrinogen

The viscosity of fibrin dissolved in urea is the same as that of the fibrinogen from which it was made, indicating particles of a similar kind in both Incidentally, fibrinogen kept in 30 per cent urea solution does not become inactivated , after dialysis it can be recovered with its full clottability[5]

When the urea is removed from a fibrin solution by dialysis at about neutral *p*H, re-clotting takes place inside the dialysis bag Solution, dialysis and re-clotting of the same specimen of fibrin can be repeated many times , and using large volumes of solvent for the repetition also ensures the elimination of the thrombin that was originally added Thus the re-clotting effect can scarcely be ascribed to thrombin Rather would it seem that the enzyme produces in fibrinogen a permanent change which thereafter always promotes clotting whenever the medium is suitable[6]

Plasma fibrin, insoluble in urea, dissolves in a mixture of 1 per cent thioglycollic acid and 30 per cent urea, and when the solvent is removed by dialysis the gel re-forms While the action of urea alone is probably no more than intermolecular, it is uncertain whether the same can be said about the action of the mixture, and until more is known about the precise nature of the dispersed units it is not possible to infer where in the plasma-clot network the splitting by urea plus thioglycollic acid occurs. Though it might be supposed that the effect of thioglycollic acid is due to its ability to reduce S–S bonds, it is very unlikely that plasma fibrin would differ from urea-soluble fibrin simply by possessing additional S–S linkages between the associated units , for it has to be borne in mind that neither fibrinogen nor urea-soluble fibrin has any free or masked sulphydryl groups available for possible S–S formation[5] Moreover, urea-soluble fibrin cannot be converted into an insoluble kind by treating with oxidizing agents such as hydrogen peroxide It is found, too, that plasma cannot be prevented from forming a urea-insoluble clot by adding chloroacetophenone or excess cysteine, so there is no indication, either, of any re-formation during clotting of the original fibrinogen S–S groups

The serum factor, which with calcium ions is responsible for the urea-insolubility of the plasma-clot, retains its activity for weeks in plasma kept at 0° C , but it is inactivated in a couple of days at room temperature It is also destroyed if serum is heated at 60° C for 10 min The factor does not dialyse out from plasma , it seems to accompany fibrinogen in the plasma fraction precipitated on adding a half plasma-volume of saturated ammonium sulphate, but separation takes place on subsequent acid precipitation (*p*H 5 2–5 4) at 0° C The serum factor is not identical with the anti-hæmophilic factor, since a hæmophilic blood-clot is like a normal one in being insoluble in urea

As serum and calcium ions must be added in fairly high proportions in order to obtain a urea-insoluble clot by the action of purified thrombin, the possibility cannot be disregarded of a stoichiometric combination between serum factor and fibrin If this idea is sound, it would suggest that the serum factor acts as a resistant cement between the fibrin units The identification of the factor is still under investigation, and it might well turn out to be one of the few serum globulins already known to have a high tendency to occlusion within the clot[7]

My thanks are due to Prof W T Astbury for his interest and encouragement, and to Dr K M Rudall and Mr W R Middlebrook for discussions I am also indebted to Hoffmann–La Roche, Basle, for the gift of a thrombin preparation

A more detailed account of this work will be published in due course elsewhere

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## Vermiculite–Organic Complexes

MONTMORILLONITE is known to be capable of forming organic complexes of two kinds, one due to a cation-exchange reaction[1] and the other to the interlamellar adsorption of complete molecules[2,3] Halloysite has also been reported as giving complexes of the latter type[2], and recently also vermiculite[4,5] Using a typical vermiculite, complexes of both types have been obtained in this laboratory, and are being studied by means of X-ray diffraction

The recent demonstration of the high exchange capacity of vermiculite for inorganic cations, together with its limited swelling properties[6,7,8], made it probable that substitution by organic cations could be effected, and this is found to be so Complexes have been formed with codeine, *p*-phenylene-diamine, benzidine hydrochloride and brucine sulphate, the amount of displacement of the vermiculite basal reflexion depending on the concentration as well as the nature of the amine It is noteworthy that the blue colour-change produced in benzidine by montmorillonite and other substances[9] is also produced by vermiculite

The existence of the van der Waals type of adsorption in vermiculite was suspected when it was found that, during the weathering of biotite to vermiculite, a stage is observed at which a single layer of glycerol molecules can penetrate the structure with displacement of the basal reflexion from about 10 A to 14 A[10] Further examination has shown that glycerol molecules do, in fact, enter the structure of true vermiculite and displace the interlamellar water, but that the effect is difficult to observe since the resulting spacing ($d_{002} = 14\ 28$ A ) is very close to that of the natural magnesium-saturated vermiculite ($d_{002} = 14\ 36$ A ) It can be observed easily in the case of vermiculite previously saturated with lithium or barium ions, both of which give a basal reflexion at about 12 2 A[8], which is displaced to 14 28 A on treatment with the glycerol Small flakes of vermiculite treated with glycerol and rotated perpendicular to the *c*-axis show the line at 14 28 A accompanied by a regular sequence of a dozen or more higher orders

In the case of ammonium-vermiculite powder, addition of glycerol displaces the basal line to only a slight extent if at all[11], suggesting at most very limited penetration by the glycerol molecules This also occurs with the other large monovalent cations tested, namely, potassium and caesium, which have similar basal spacings, and is probably due to the fact that when these ions enter the structure (which they do with difficulty) they are not associated with layers of water molecules as is the magnesium ion in natural magnesium-vermiculite As a consequence of this, the alumino-silicate layers are able to approach each other more closely and can be re-separated only with difficulty

The other organic molecules tested so far, namely, those of ethylene glycol, methanol, cyclohexanol, acetone and acetonitrile, show only limited penetration of the magnesium-vermiculite structure or none at all If lithium-vermiculite is used, however, complex formation becomes easier in some cases

It is clear that the adsorption mechanism of the glycerol molecule in vermiculite differs in certain respects from the corresponding process in montmorillonite In glycerol – montmorillonite, the organic molecule orientates itself so that it is about 3 9 A high, and double layers of molecules penetrate the structure[2] In the case of glycerol – vermiculite, the interlamellar space available for the organic molecules is 5 0 A high, and there is evidence that this is real spacing and not a mixed-layer effect Hence, in glycerol – vermiculite, apart from the fact that only *single* layers of glycerol molecules are interleaved with the alumino-silicate layers, the organic molecules either (*a*) attach themselves to the clay mineral surfaces by a weaker binding force than exists in glycerol – montmorillonite, or (*b*) orientate themselves differently with respect to the adjacent alumino-silicate surfaces. In vermiculite, moreover, the nature of the exchangeable cation present may influence indirectly the degree of complex formation.

An interesting additional point is the catalytic effect exerted by vermiculite on the decomposition of glycerol. If a small flake of vermiculite is boiled for a few minutes in glycerol, it acquires a black metallic coating (on the interlamellar surfaces as well as at the boundaries of the crystal). An X-ray photograph shows that the basal spacing has moved to 14·06 A (with a regular series of higher orders). This would be consistent with the existence between the silicate lamellæ of *double* layers of carbon atoms arranged as in the graphite structure[12]. Fourier curves (along the *c*-axis) of this and of the normal glycerol – vermiculite structure are being prepared.

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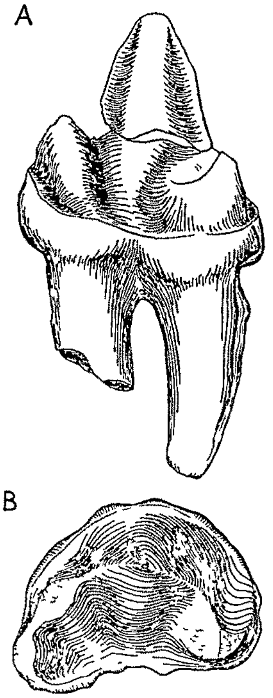
## A Symmetrodont Tooth from the Rhaeto-Lias

SINCE the discovery of the tooth *Morganucodon watsoni* in a fissure at the Duchy Quarry near Bridgend, Glamorgan, which yields a Rhaeto-Liassic mammalian fauna, about fifty teeth or fragments of teeth have been found. With few exceptions the fauna consists of 'Triconodonts', identical with those collected by Prof. B. Peyer from Upper Rhaetic bone-bed material at Hallau near Schaffhausen. The only members of the fauna which are adequate for comparison with other material are the 'Triconodonts'. I wish to emphasize that all the known facts having a bearing on the geological age of the *Morganucodon* fissure are consistent with a Rhaeto-Liassic age.

On *Morganucodon* a few new points may be given. If one looks upon this lower post-canine as a 'pre-pantothere', the changes needed to lead to the pantotheres would be the following: the anterior accessory cusp which in *Morganucodon* is very small would have to disappear, and the antero-internal cingulum cusp would have to increase in size to make the paraconid. The highest cingulum cusp, well separated in *Morganucodon*, would also have to increase in order to form the metaconid. The very substantial posterior accessory cusp in *Morganucodon* would have to disappear and the talonid to become basined.

Dr. P. M. Butler has suggested to me that *Morganucodon* might be a 'predocodontid' and compared the specimen with *M*4 of *Peraiocynodon inexpectatus* from the Middle Purbeck of Swanage, Dorset. The disappearance of the rather large posterior accessory cusp of *Morganucodon* would make the two teeth agree in structure.



"Duchy 33", a symmetrodont tooth from the Rhaeto-Lias. *A*, internal view; *B*, crown view. Length of specimen 1·25 mm.

The posterior tooth preserved in *Microconodon tenuirostris* from the Rhaetic of North Carolina, shown presumably from the outer side, is surprisingly similar to the outer view of *Morganucodon*.

During recent work at the Duchy Quarry my wife found a fragment of matrix, and on inspecting it I detected a mammalian tooth. While the specimen was being prepared, a small part of the base of the main cusp was lost, and in consequence the true fitting of the main cusp is impossible; otherwise the specimen is complete and well preserved. The specimen can easily be described as a lower symmetrodont cheek tooth; in fact, there is not one character at variance with this identification.

The tooth is tricuspid, the central cusp being twice as high as the lateral ones. The three cusps include an angle of about 100°. They emerge from a common base which is indented on the inner side as well as on the outer side between the free apexes of the three cusps. The cingulum is smooth and surrounds the tooth completely. There is on the inner side of the crown no basin between the three cusps. Two well-separated roots are present. The enamel is smooth. The apexes of the two lateral cusps are worn away. The specimen has the laboratory number "Duchy 33".

It is therefore certain that I was incorrect in stating in my first paper on the *Morganucodon* fauna[1] that the Triconodonts in this fauna were the only representatives of mammalian life then in existence. There are at least two types of mammalian teeth present in the Rhaeto-Lias belonging to two of the four orders recognized as mammalian in the Upper Jurassic.

But in spite of the numerous tricuspid teeth from the Rhaeto-Lias which look mammalian, we still do not know whether the animals to which the teeth belonged had a compound lower jaw or a simple one , in other words, whether the mammalian tooth development took place in a reptilian or in a mammalian jaw The Tritylodontids show that the former was actually realized in the Ictidosauria

Another question which now arises is whether we may expect even pantotherian teeth in the Rhaeto-Lias At the moment we do not possess such a tooth and we are still at liberty to build sequences of 'grades' or phylogenies and similar schemes without being encumbered by it

One may still assert that *Morganucodon* gave rise to the Pantotheria, and that the Symmetrodonta arose independently One might assert that the co-existence of 'Triconodonts' (in order to make *Morganucodon* a triconodont one has anyhow to widen the diagnostic borders of the order Triconodonta) and Symmetrodonts in the Rhaeto-Lias is a logical demand of the Cope–Osborn theory, and the fact of this co-existence would be a criterion for its correctness In that event, however, *Morganucodon* could not be regarded as a prepantothere

For the solution of these problems we require a much more extensive mammalian fauna from the Mesozoic than we at present possess This need is further emphasized by the existence of the tooth described above

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## Order of Genes in the Fifth Linkage Group of the House Mouse

WORK carried out in this Department during the past two years on the fifth linkage group in *Mus musculus* has established the order circler (*kr*), agouti (*A*), undulated (*un*), wellhaarig (*we*) and pallid (*pa*)[1] Recent work also suggests that a gene (*pl*) modifying the frequency of manifestation of polydactyly is located in this region, possibly between *A* and *pa* Mrs Wallace[2], also working in this Department, determined a linkage of the order of 25 per cent recombination between fidget (*fi*) and Danforth's short tail (*Sd*) About the same time, Carter and Gruneberg[3] ascertained a linkage of about 33 5 per cent recombination between fidget and agouti Earlier work, both at Cambridge and at the Jackson Memorial Laboratory, Bar Harbor, showed indications of a loose linkage (about 40 per cent recombination) between *A* and *Sd* Thus there was clear evidence of a second series of loci in the order *A*—*fi*—*Sd*

The relation between these two series was, however, still in doubt To determine the order of the loci *A*, *pa* and *Sd*, as one of four projects concerning the fifth chromosome and using stock available in this Department, I set up triple backcrosses of the types

$$Sd\ A\ +/+\ a^t\ pa = +\ a^t\ pa/+\ a^t\ pa, \tag{1}$$

and

$$Sd\ a^t\ +/+\ A^y\ pa = +\ a^t\ pa/+\ a^t\ pa, \tag{2}$$

the heterozygous parent being male in sixteen of the matings and female in two

The offspring must fall into four (double) phenotypic classes, for example, in case (1) (genotypes written vertically)

$$\begin{array}{cccc} \text{I} & \text{II} & \text{III} & \text{IV} \\ \overbrace{\begin{matrix} Sd & + \\ A & a^t \\ + & pa \end{matrix}} & \overbrace{\begin{matrix} + & Sd \\ A & a^t \\ + & pa \end{matrix}} & \overbrace{\begin{matrix} Sd & + \\ A & a^t \\ pa & + \end{matrix}} & \overbrace{\begin{matrix} Sd & + \\ a^t & A \\ + & pa \end{matrix}} \end{array}$$

Kosambi's theory of recombination[4] (using provisional recombination values, *Sd*—*A* 42 per cent and *A*—*pa* 15 per cent) gives two sets of expected frequencies for these classes, depending on the orders

(*a*) *Sd*—*A*—*pa* or (*b*) *Sd*—*pa*—*A*

Out of a total of 277 mice bred from both types of mating, the observed and expected class numbers were

| | I | II | III | IV |
|---|---|---|---|---|
| Obs | 135 | 96 | 16 | 30 |
| Exp *a* | 134 9999 | 100 4501 | 25 6601 | 15 8899 |
| Exp *b* | 148 0617 | 87 3883 | 12 5983 | 28 9517 |

To compare the goodness of fit of the rival hypotheses, $\chi^2$, calculated on three degrees of freedom, comes to

| | $\chi^2_3$ | P |
|---|---|---|
| Hyp (*a*) | 16 36 | < 0 01 |
| Hyp (*b*) | 2 96 | 0 5–0 3 |

These observations are therefore in good agreement with the order

*Sd*—*pa*—*A*,

and in strong disagreement with the alternative order This makes the order of these seven factors

*kr*—*A*—*un*—*we*—*pa*—*fi*—*Sd*

A fuller account of this work will be published later in *Heredity*

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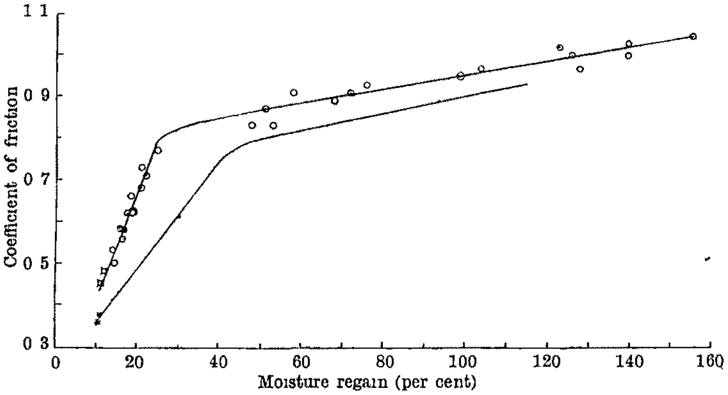
## Effect of Moisture on the Frictional Properties of Jute Fibre

IN connexion with the measurement of frictional characters of jute fibre (a full report of which will be published elsewhere) by allowing a fibre pad on a metal block to slide over another the inclination of which could be increased gradually, the following results on the effect of relative humidity on the coefficient of friction ($\mu$)—fibres sliding parallel to one another—were obtained

| Sample *A* | | Sample *B* | |
|---|---|---|---|
| Relat humidity (per cent) | $\mu$ | Relat humidity (per cent) | $\mu$ |
| 78 | 0 54 | 80 | 0 56 |
| 58 | 0 46 | 62 | 0 48 |
| 46 | 0 41 | 43 | 0 37 |

The samples were conditioned in desiccators over appropriate solutions for seven days or more, and were tested for friction when the room conditions were at about the corresponding relative humidities As in the case of other textile materials[1,2], between 40 and 80 per cent relative humidity, the coefficient of friction of jute fibre appears to increase approximately linearly with relative humidity

In order to see the change beyond the above range of humidities, particularly when jute contains more moisture than that corresponding to the saturation vapour pressure of water, several jute bundles were soaked in distilled water for 15 min , squeezed and allowed to dry in a slow current of air at about 60 per cent relative humidity At different intervals of time the bundles were taken one after another and put into stoppered bottles to allow the interior and the surface moisture to reach equilibrium After one hour (which is not, however, sufficient for equilibrium), each bundle was tested for friction Immediately after each test, the pads were put inside the bottle for the determination of moisture regain A correction for the loss of moisture during the experiment was found by measuring the rate of loss by evaporation from the bundle before putting into the oven The bundle, tested immediately after squeezing, had a regain of more than 100 per cent, depending on the pressure applied, while that dried in an air current for four hours had a regain of about 14 per cent The readings for the individual bundles of two varieties of jute have been plotted in the accompanying graph The curves are for desorption



O—O, Tossa jute, — —, white jute, x—x—, without soaking

The interesting features of the curves are that (1) each of them shows two distinct linear regions at low and high regains, with a short curved region intervening, between 25 and 40 per cent regain in one case and 35 and 50 per cent in another, indicating a change of behaviour of the fibre surface as it passes from one region to the other, and (2) at lower regains, the friction is rather sensitive to moisture, though not equally for both the fibres, whereas above 50 per cent regain the effect is less pronounced, being practically the same for both

A probable explanation seems to be that the water molecules adsorbed on the fibre surface (but not in the interior) form a bond between the pads, and as the number of such bonds increases, friction correspondingly increases, after a certain stage, when a multilayer film has been formed, the proportion of water molecules contributing to the surface bonding falls and the slope of the curve diminishes

This may throw some light on the mechanism of moisture adsorption on the fibre surface at different moisture conditions Further work on these lines is in progress

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## A New Cholinesterase in Swine Serum

THERE are at present two groups of enzymes in mammals which hydrolyse acetylcholine the first hydrolyses acetylcholine and acetyl-β-methylcholine and is found primarily in nervous tissue and red blood cells , the second group hydrolyses acetylcholine and benzoylcholine and is found in the serum and tissues of some animal species Characteristic of this last group is the enzyme in human serum. In addition, there is one other related enzyme or group of enzymes which hydrolyses benzoylcholine but not acetylcholine This was first noted and labelled benzoylcholinesterase by Sawyer[1], and was reported by us as occurring in rabbit serum[2]

We are now reporting a new enzyme which hydrolyses acetylcholine, but neither benzoylcholine nor acetyl-β-methylcholine to any significant degree This enzyme was observed in swine serum, and was found to yield 160 to 260 microlitres carbon dioxide per c c in eight pigs studied The methods of determination are identical with those described by us in a recent paper[2]

Pontocaine inhibition has been used in the classification of these enzymes Swine serum cholinesterase activity is inhibited completely by $10^{-4}$ *M* pontocaine, and in this respect is similar to the cholinesterase of human serum However, the human serum enzyme hydrolyses acetylcholine and benzoylcholine in a constant ratio, and since the swine serum does not hydrolyse benzoylcholine, it must be considered a separate enzyme

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## Alkaline Hydrolysis of Trichothecin

THE preparation, and biological and preliminary chemical properties of trichothecin, an antifungal substance from *Trichothecium roseum* Link, have been described[1] From the data then available it was erroneously concluded that the compound was a lactone with the probable molecular formula $C_{15}H_{20}O_4$ Further work has shown that trichothecin is an ester, $C_{19}H_{24}O_5$, the components of which are *iso*crotonic acid and a ketonic alcohol, trichothecolone

The antifungal compound gave on analysis (Weiler and Strauss) C = 68 9, 68 5, 68 7, 68 8, 68 9 , H = 7 2, 7 2, 7 3, 7 4, 7 5 per cent , mol wt (Rast) = 332, 312, 320 , $C_{19}H_{24}O_5$ requires C = 68 6 , H = 7 3 per cent , mol wt = 332 Trichothecin 2 4-dinitrophenylhydrazone (m p 203°) gives C = 58 6, 58 7 , H = 5 2, 5 2 , N = 10 5, 10 8 per cent , $C_{25}H_{28}O_8N_4$ requires C = 58 6 , H = 5 5 , N =

10 9 per cent Trichothecin forms an addition compound on treatment with concentrated aqueous hydrochloric acid (m p 132 5°), found C = 61 8, H = 6 8, Cl = 9 4 per cent, $C_{19}H_{25}O_5Cl$ requires C = 61 8, H = 6 8, Cl = 9 6 per cent

Hydrolysis in the cold with a methanolic solution of potassium hydroxide gave the ketonic alcohol, trichothecolone (m p 182°), which was extracted from the alkaline solution with chloroform (found C = 68 8, 68 9, H = 7 3, 7 3, (C)$CH_3$ = 10 0, 10 6 per cent, mol wt (Rast) = 244, 248 $C_{15}H_{20}O_4$ requires C = 68 2, H = 7 5, two (C)$CH_3$ groups = 11 4 per cent, mol wt = 264) Acidification of the aqueous liquor and extraction with chloroform gave a colourless, liquid acid (b p 210°), found C = 51 4, 51 6, H = 8 4, 8 8, methoxyl = 21 8, active hydrogen = 0 86 per cent, acid equivalent = 116 $CH_3O\,C_3H_6\,COOH$ requires C = 50 9, H = 8 6, methoxyl = 26 3, active hydrogen = 0 85 per cent, acid equivalent = 118 The *p*-phenylphenacyl ester (m p 60°) was prepared, found C = 72 5, 72 4, H = 6 3, 6 4 per cent $C_{19}H_{20}O_4$ requires C = 73 0, H = 6 5 per cent Since the methoxyl group is absent in trichothecin, it appeared likely that addition of methyl alcohol had taken place, during hydrolysis, probably at a reactive double bond Purdie and Marshall[2] showed that ethyl crotonate on treatment with sodium methoxide gave sodium β-methoxy-*n*-butyrate We have submitted ethyl crotonate to hydrolysis under the conditions used for hydrolysis of trichothecin The acidic product (b p 210°, acid equivalent 114) was identical with the acid obtained on hydrolysis of trichothecin This acid formed a methyl ester (b p 144–148°) and an amide (colourless scaly crystals, m p 68°) and it was concluded that the acid is β-methoxy-*n*-butyric acid

The trichothecin molecule contains two ethylenic groups, and the ultra-violet absorption spectrum indicates that one of these is conjugated with a carbonyl group[1b] Reduction with hydrogen at atmospheric pressure in the presence of palladized charcoal gave tetrahydrotrichothecin, a colourless syrup, which gave by Allen's method a 2 4-dinitrophenylhydrazone, $C_{21}H_{26}O_7N_4$ (m p 112–113°) Hydrolysis of tetrahydrotrichothecin, under the conditions described above, gave *n*-butyric acid and dihydrotrichothecolone, $C_{15}H_{22}O_4$ The acid gave a *p*-phenylphenacyl ester (m p 81°), found C = 76 8, H = 6 3 per cent, $C_{18}H_{18}O_3$ requires C = 76 6, H = 6 4 per cent The mixed melting point with authentic *p*-phenylphenacyl-*n*-butyrate (m p 82°) was undepressed

Hydrolysis of trichothecin by heating its methanol solution with an equal volume of a saturated aqueous solution of barium hydroxide gave β-methoxy-*n*-butyric acid and *iso*trichothecolone, $C_{15}H_{20}O_4$

Trichothecin dissolved rapidly on vigorous boiling with an excess of 0 5 *N* aqueous sodium hydroxide Extraction of the reaction product in the usual manner gave *iso*trichothecolone and a liquid acid, which reduced ammoniacal silver nitrate, the crude acid had an acid equivalent of 90 It gave a *p*-phenylphenacyl ester (m p 102–3°), found C = 76 8, 77 2, H = 5 8, 5 7 per cent, $C_{18}H_{16}O_3$ requires C = 77 1, H = 5 7 per cent *Iso*crotonic acid was prepared by the method of Michael and Schulthess[3] The melting point of *p*-phenylphenacyl *iso*crotonate (m p 102–3°) was undepressed on admixture with the above ester, while that of *p*-phenylphenacyl crotonate (m p 106°) was depressed to 92°

Acetaldehyde was isolated as the 2 4-dinitrophenylhydrazone on ozonolysis of trichothecin, which is in agreement with the presence of a propenyl group in the *iso*crotonic acid component

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## Histochemical Demonstration of Lipase

The lipase method of Gomori[1] has been little used in morbid histology This communication is concerned with the results of a preliminary study of the distribution of lipase in human tissue using Gomori's method The method, which is one of his ingenious techniques using the deposition of an insoluble calcium salt at the site of enzyme activity, is based on the splitting of a water-soluble ester of higher fatty acids and conversion of the calcium soap to lead sulphide The original method[1] and the modification of Wachstein[2] were satisfactory, using as substrate Tween 40 or 60 as recommended by them, or Crill 6 or 7, which is a similar British product (Croda, Ltd , Goole, Yorks)

The results obtained were variable, depending on a number of factors such as postmortem change, length of fixation in acetone, lengthy heating during paraffin embedding, floating sections on water instead of 70 per cent acetone, overheating of slides to ensure adherence of sections and using material blocked for some months It would appear that the lability of the enzyme accounts for the various factors producing negative results It has been suggested by Mark[3] that frozen sections of formalin-fixed tissue may be better than paraffin sections

In carrying out the two methods used, it was noticed that the *p*H of the substrate mixture tended to fall, and must be maintained close to 7 4 during incubation Adjusting the *p*H without using a buffer was not satisfactory If the mounted sections are overheated, the lead sulphide may dissolve Cobalt replacement was not successful Heat or treatment with Lugol's iodine was used to inactivate the enzyme in control slides

The results obtained confirm most of Gomori's findings[4] The hepatic cells of the liver and the acinar cells of the pancreas were strongly positive, as were desquamated macrophages in lung alveoli There was patchy activity in fat and bronchial epithelium, and weak activity in the interstitial cells of the testis Faint staining of red cells, cartilage and keratin was probably due to the adsorption of lead, as they were also faintly positive in the control slides Negative results were obtained with other organs, including lymph nodes, bone marrow, lactating breast, kidney and two pancreatic carcinomas

Despite theoretical objections to enzyme methods[5], they may become valuable diagnostic tools in the future It is surprising that the pancreatic carcinomas were negative This may be due to the fact that the tumours arose from duct epithelium or to the fact that neoplasia has abolished cell function The reaction of the liver may be due in part to esterases

The lipase in some macrophages suggested the trial of macrophages in tissue culture, Dr Charity Waymouth kindly gave me some tissue cultures of chick heart and Rous sarcoma No 1 The macrophages of the former were slightly positive, of the latter negative although they contained fat globules Probably the resting macrophage contains little lipase, but when actively phagocytic may elaborate a good deal

Both Gomori's and Wachstein's histochemical methods for demonstrating lipase in tissue cells require further improvement before they can be relied upon to give consistent results and, therefore, to be of value in diagnostic work

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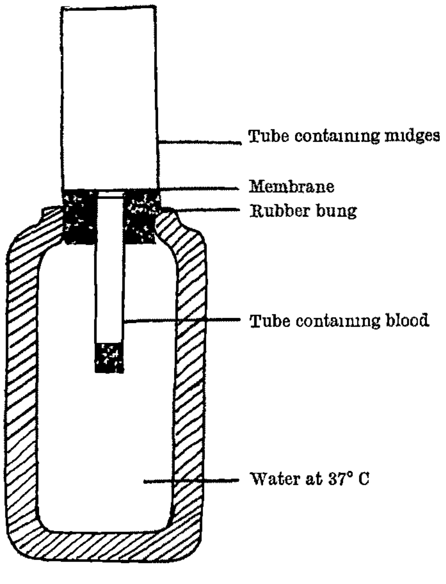
## Artificial Feeding of *Culicoides nubeculosus* in the Laboratory

Although the normal hosts of *Culicoides nubeculosus* are horses and cattle, they will readily bite man in the laboratory, and a strain has been maintained in this way, but as the numbers increased it became essential to devise a method by which they might be fed artificially At 20° C, the temperature at which the strain is kept, the females will take their first blood meal three days after emergence, will oviposit two to three days later and require a further blood meal before they will oviposit again The duration of the life-cycle is four to five weeks

The method was based on that used by Bishop and Gilchrist[1] for the feeding of *Aedes ægypti* Unlike *A ægypti*, *C nubeculosus* in a large container will not readily seek its food, nor can it be induced to feed through gauze The midges were therefore enclosed in a small tube and could be in direct contact with the membrane The apparatus is shown in the diagram A vacuum flask served as a constant temperature bath and was filled with water at 37° C The membranes were made from pieces of chicken skin which were soaked in absolute alcohol for thirty minutes and washed, these could be dried for storage and became flexible again when soaked in water Midges were withdrawn from the breeding cages into 4 in × 1 in tubes which were inverted over the membrane It was found that unless the membrane was distended by blood under slight pressure, the proboscis of the insect was so short that air bubbles tended to form immediately below the membrane, the necessary pressure was obtained by filling the tube completely before closing with the rubber bung and laying the whole apparatus on its side during the experiment



Bishop and Gilchrist have already commented on the relative merits of whole blood, defibrinated blood and plasma, and also of heparinated and citrated blood In the present experiments, results were obtained only on the comparative merits of the human subject, heparinated ox blood and citrated ox blood Ox blood was withdrawn from the veins and was sufficiently sterile to be stored at 4° C for twelve days To allow for storage, heparin was used at a dilution of 1/1,000

All the midges used were three to four days old and of the same generation in each experiment The total number was divided into three, one-third being offered a human subject, one-third heparinated blood and one-third citrated blood

Relative Merits of Human Blood, Heparinated and Citrated Ox Blood for the Feeding of *C nubeculosus*

| No of females offered food | No which fed | No which oviposited | Average No eggs laid | Length of life | |
|---|---|---|---|---|---|
| 84 | 71 (72 6%) | 48 (67 6%) | 380 | 4–7 days | Human subject |
| 77 | 56 (70 1%) | 38 (67 8%) | 371 | 4–7 days | Heparinated ox blood |
| 61 | 20 (32 8%) | 10 (50%) | 247 | 3–5 days | Citrated ox blood |

From the results shown in the accompanying table, it will be seen that only 32 8 per cent of the midges offered citrated blood fed, whereas 70 1 and 72 6 per cent fed on heparinated blood and the human subject respectively On several occasions 100 per cent of the females have fed when offered both heparinated and human blood

Only 50 per cent of the females which fed on citrated blood afterwards oviposited, but 67 8 and 67 6 per cent oviposited of those fed on heparinated and human blood The average number of eggs laid by the group fed on citrated blood was considerably less than that laid by the other two groups, and the average length of life of the females was also less Consequently, citrated blood was regarded as being unsuitable, and it seems that heparinated blood is an adequate substitute for the human subject

Enid W Roberts

Department of Zoology,
University,
Glasgow, W 2

June 21

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[1] Bishop, Ann, and Gilchrist, B, *Parasit*, **37**, 85 (1946)

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, October 23

Society of Dairy Technology (at the Conway Hall Red Lion Square, London, W C 1), at 10 30 a m—Annual General Meeting, at 2 30 p m—Dr J G Davis and Dr T Ashton "Laboratory Control of Processing and Manufacture"

Royal Meteorological Society, Scottish Centre (in the Department of Natural Philosophy, The University, Drummond Street Edinburgh), at 5 15 p m—Display of meteorological films, including "Seeding the Clouds", by Mr V J Schaefer

British Society for the History of Science (in the Lecture Room, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m—"The Scientific Work of Descartes" (Dr J F Scott "Descartes' Contributions to Physics", Dr A C Crombie 'Descartes' Contributions to Biology and Scientific Method")

Institution of the Rubber Industry, Manchester Section (at the Engineers' Club, Albert Square, Manchester) at 6 15 p m—Mr E Morris "Engineering in the Rubber Industry"

## Tuesday, October 24

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m—Mr G P Wells "The Behaviour of Worms" * (Further Lecture on October 31 )

Chadwick Public Lecture (in the Meyerstein Lecture Theatre, Westminster Medical School, 17 Horseferry Road, London, S W 1), at 4 30 p m—Dr Neville M Goodman "Public Health Administration in Western Union Countries—a Comparative Synthesis" *

Royal Anthropological Institute (at 21 Bedford Square, London, W C 1), at 5 p m—Mlle Jeanne A L Cuisinier 'The Sacred Dance in Indo-China and Indonesia"

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 15 p m—Prof H Hartridge, F R S ' Some Recent Advances in the Physiology of Vision" * (Further Lectures on October 31 and November 7 )

Royal Society of Medicine, Medicine Section (at 1 Wimpole Street, London, W 1), at 5 30 p m—Discussion on "Medical Education" (to be opened by Dr L Birley)

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m—Dr J H Chesters "Flow Patterns in Furnaces"

Textile Institute (at St Mary's Parsonage, Manchester), at 6 30 p m—Mr C S Newton "Carpets and their Manufacture" (Technicolor sound film, followed by discussion)

Textile Institute, Yorkshire Section (at the University, Leeds), at 7 15 p m—Mr L G Humble "Work Study"

## Wednesday, October 25

Institute of Physics, Education Group (in the Fyvie Hall, The Polytechnic, Regent Street, London, W 1), at 3 p m—Lord Eustace Percy ' Technical Universities"

Chemical Society, Glasgow Section (joint meeting with the Alchemists Club and the Andersonian Chemical Society, at the Royal Technical College, Glasgow), at 3 30 p m—Prof R P Linstead, F R S "Recent Developments in Macrocyclic Pigments"

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m—Prof Dr H A Brouwer (Amsterdam) "Movements of Island Arcs" (Sixth William Smith Lecture)

Physical Society Acoustics Group (in the Anatomy Theatre, University College, Gower Street, London W C 1), at 5 p m—Mr E W Ayers and Mr J Y Morton "The Subjective Calibration of Bone Conduction Receivers for Hearing Aids"

British Association for the Advancement of Science (at the Royal Institution, Albemarle Street, London, W 1), at 5 15 p m—Sir Lawrence Bragg, F R S "Science and the Adventure of Living" (Radford Mather Lecture)

Manchester Literary and Philosophical Society Chemical Section (in the Reynolds Hall, College of Technology, Manchester), at 5 30 p m—"Stainless Steel" (Technicolor films prepared by the staff of Firth Vickers and Co Ltd )

University of London (at King's College, Strand, London, W C 2), at 5 30 p m—Prof C F Powell, F R S "Cosmic Radiation" * (Further Lectures on October 26 and 27 )

University of London (in the Department of Electrical Engineering, University College, Gower Street, London, W C 1), at 5 30 p m—Mr A H W Beck "Ultra High Frequency Valves" * (Further Lectures on November 1, 8, 15, 22, 29 and December 6 )

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 15 p m—"Factors in Distribution affecting the Quality and Nutritional Value of Foodstuffs, 1, Fish and Meat" (Speakers Dr G A Reay, Dr E H Callow and Dr Magnus A Pyke)

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6 30 p m—Mr R S Jackson "Review of Current Research on Springs and Spring Steels"

Plastics Institute, London and District Section (at the Waldorf Hotel, Aldwych, London, W C 2), at 6 30 p m—Dr V E Yarsley "The Limitations of Plastics"

British Association of Chemists (at the Wellcome Research Institution, 183 Euston Road, London, N W 1), at 7 p m—Mr C E Hollis "Research Aspects of Polyvinyl Chloride Plastics" (Members of the Plastics and Polymer Group of the Society of Chemical Industry are invited )

Institution of Works Managers (at the Waldorf Hotel, Aldwych, London, W C 2)—Annual General Meeting

## Thursday, October 26

Textile Institute (at the Mechanics' Institute, Burnley), at 10 a m—Conference on "Yarn Preparation"

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S W 7), at 3 p m—Scientific Papers

East Malling Research Station (at Withersdane, Wye College, Wye, Ashford, Kent) at 4 p m—Sir Edward Salisbury, F R S "The Fruit Tree and its Environment"

Linnean Society (at Burlington House, Piccadilly, London, W 1), at 5 p m—Mr F J Manning "Recent and Fossil Honey Bees—Some Aspects of their Psychology Phylogeny and Evolution", Prof J McLean Thompson "On the Cannon Ball Tree (*Couroupita guianensis* Aubl )"

Royal Institute of Chemistry, Manchester and District Section (in the Chemistry Lecture Theatre, The University, Manchester), at 6 30 p m—Sir Charles Goodeve, F R S "The Physical Chemistry of Iron and Steel" (Sixth Dalton Lecture)

Chemical Society, Edinburgh Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7 30 p m—Dr A E Werner "The Scientific Examination of Pictures"

Royal Aeronautical Society, Graduate and Student Section (at 4 Hamilton Place, London, W 1), at 7 30 p m—Mr J A Dunsby "The Aerodynamics of Compressor and Turbine Cascades"

Association of Scientific Workers (in Committee Room No 4, Church House, Westminster, London, S W 1), at 7 45 p m—Prof T'u Chang-wang and Prof Chou Pei-yuan "Science in China To-day" *

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7 45 p.m—Mr B J Thomas "Modern Developments in Pharmaceutics"

## Friday, October 27

Aslib, Northern Branch (in the Lecture Room, Central Library, St Peter's Square, Manchester), at 11 30 a m—Annual General Meeting, at 2 15 p m—Mr W H Glasscock and Mr Horrocks "Government and Official Publications"

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p m—Discussion on "Form Grinding by Mechanical and Optical Methods" (to be opened by Mr E A Cooke)

Manchester Statistical Society, Industrial Group (at the Albert Hall, Peter Street, Manchester), at 6 45 p m—Mr A W Swan "An Operational Research Project based on Time Study Data"

Television Society (at the Cinema Exhibitors' Association, 164 Shaftesbury Avenue, London, W C 2), at 7 p m—Dr Leonard Levy and Mr D W West "Modern Phosphors for Television C R Tubes"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Agricultural Entomologist—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (October 28)

Junior Assistant Physicist—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx (October 28)

Lecturer in Chemistry at Coventry Technical College—The Director of Education, Council House, Coventry (October 28)

Lecturer in Chemistry, and a Lecturer in Mathematics and Physics—The Director, Robert Gordon's Technical College, Aberdeen (October 28)

Lecturer in the Department of Physics and Telecommunications—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S E 18 (October 28)

District Engineers (Ref E 129/50A), a Municipal Engineer (Ref E 129/50A), and a Road Engineer (Ref E 130/50A), in the Public Works Department under the Government of Cyrenaica—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (October 30)

Analytical Chemist—The Director, Brewing Industry Research Foundation 40 Sackville Street, London W 1 (October 31)

Assistant in Statistical Research—The Secretary, Faculty of Economics and Politics, The Marshall Library, Downing Street, Cambridge (October 31)

Clinical Physicist to assist with the routine and research work in connexion with the Department of Radiotherapy—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S W 3 (October 31)

Meteorological Officers (6, with honours university degree covering physics, mathematical physics or mathematics, or civil, mechanical or electrical engineering, or a university degree in meteorology) in the Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 31)

Micro-analytical Assistant—The Technical Superintendent, Brewing Industry Research Foundation, Nutfield, Surrey (October 31)

Physicist to assist in work with radioactive isotopes—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S W 3 (October 31)

Lecturer (Grade I) in Civil Engineering—The Secretary, The University, Birmingham 3 (November 1)

Horticulturist, and an Assistant Mycologist, to the States of Jersey—The Secretary, Committee of Agriculture, Jersey (November 4)

Research Chemist (Scientist, Grade III) at the Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place, London, S W 1 quoting TT/262 (November 4)

Research Fellowship in Chemistry—The Secretary, The University, Aberdeen (November 6)

Technical Assistant (male with a University degree in engineering or science or equivalent qualifications together with knowledge of, and practical experience in, control of work in geodesy applied to mapping and aerial navigation, map construction and cartography, process photography and lithographic reproduction), to the Head of Establishment at the Air Ministry Survey production centre at Teddington—The Secretary Civil Service Commission, Scientific Branch, London, W 1, quoting No 3310 (November 9)

Assistant Lecturer in Economics—The Registrar, The University, Manchester (November 10)

Research Assistant in Economics or Economic Statistics—The Registrar, The University, Manchester (November 10)

Senior Lecturer in Bacteriology in the Department of Pathology—The Secretary, Institute of Ophthalmology, Judd Street, London, W C 1 (November 10)

Chief Engineer and a Chief Pollution and Fisheries Officer—The Clerk of the Wear and Tees River Board, Clark's Yard, High Row, Darlington, Co Durham (November 11)

Lecturer or Assistant Lecturer in the Fluid Motion Laboratory—The Registrar, The University, Manchester 13 (November 11)

Chemist and Bacteriologist—The Engineer and Manager Water Department, Town Hall, Reading, endorsed 'Chemist and Bacteriologist' (November 13)

Senior Experimental Officers and Experimental Officers at Admiralty Experimental Establishments in various parts of Great Britain Mechanical Engineers (Ref C 267/50) with research and development experience in light mechanisms, Electrical Engineers (Ref D 152/50), or Physicists (Ref A 146/50) with research and development experience in light electrical mechanisms, electronics or acoustics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (November 13)

Chair of Civil Engineering at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 15)

Lecturer in Biochemistry (with special qualifications in biochemistry or organic chemistry and, preferably, experience in dairy chemistry or chemistry of foods)—The Registrar, Massey Agricultural College, Palmerston North, New Zealand (November 15)

Lecturer in the Department of Geography, University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 15)

Lecturer in Mechanical Engineering at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 15)

Senior Lecturer and a Lecturer in Psychology at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 15)

Senior Tobacco Extension Officer (with a degree in agriculture at an approved university normally involving a four-year course) in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W C 2 (November 15)

Deputy Chief Scientific Officer at a Research and Development Establishment near London, to take charge of all the engineering groups in the Establishment—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3324 (November 16)

Chair of Pharmacology—The Registrar, The University, Liverpool (November 18)

Head of the Department of Mathematics, Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 18)

Agricultural Economist in the Ministry of Agriculture and Fisheries, and Assistant Agricultural Economists (3 in the Ministry of Agriculture and Fisheries and 3 in the Department of Agriculture for Scotland)—The Secretary, Civil Service Commission, Burlington Gardens, London, W 1, quoting No 3326 (November 24)

Brunner Chair of Economic Science—The Registrar, The University, Liverpool (November 25)

Senior Lecturer in Botany at Canterbury University, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 27)

Assistant Lecturer or Lecturer in Botany at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 30)

Assistant Lecturer or Lecturer in Mechanical Engineering at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 30)

Chair of Agriculture at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 30)

Mechanical Engineer in the State Hydro electric Department, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W C 2 (November 30)

Professor of Agricultural Chemistry—The Secretary and Registrar, University College of North Wales, Bangor (November 30)

Professor of Civil Engineering, and a Professor of Physics, at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London W C 1 (November 30)

Research Assistant in Radiochemistry—The Secretary, The University, 38 North Bailey, Durham (November 30)

Senior Lecturer or Lecturer in Botany at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 30)

Assistant Electrical Engineer in the Railway Department, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27326/40

Assistant Experimental Officer in the Department of Chemistry, for duties requiring a capacity to carry out mathematical computations—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks

Assistant Experimental Officers in various Government Departments, divided between (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) engineering subjects and (*d*) miscellaneous (including, e g , library and technical information services)—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W-1, quoting No 3068

Assistant Lecturer and Demonstrator in the Chemistry Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W 8

Chemists, Physicists and Metallurgists (men and women) as Senior Experimental Officers or Experimental Officers in the Research, and Test and Inspection Branches of the Post Office Engineering Department—The Engineer-in-Chief, Staff Branch (St 1), Alder House Aldersgate Street, London, E C 1

Development Assistants at the Admiralty Engineering Laboratory, West Drayton, for experimental and development work in connexion with electrical equipment of warships—The Admiralty, C E II, Room 88, Empire Hotel, Bath

Engineering Assistant by the Government of Northern Rhodesia—The Crown Agents for the Colonies, 4 Millbank, London, S W 1 quoting M N 24886/3A

George Holt Fellowship in Physiology—The Registrar, The University, Liverpool

Government Analyst in Barbados—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27106/44/50

Inspectors of Mines, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27099/13

Lecturer in Botany (with particular interest in plant physiology) for classes to B Sc (special) Degree standard—The Clerk, Northern Polytechnic, Holloway, London, N 7

Nutrition Officer (woman) in H M Colonial Service, Nigeria, to investigate and advise upon nutrition problems—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27321/4

Petrologist, or a Physical Chemist with a knowledge of petrology—The Director of Research, British Ceramic Research Association, Queens Road, Penkhull, Stoke-on-Trent

Physical Chemist (with a good degree in physical chemistry) to carry out research on high temperature physico-chemical processes of interest in iron and steel making—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W 1

Physicist (with honours degree in physics and hospital experience of radium and X-radiation) in the Radiotherapy Department of the Kent and Canterbury Hospital—The Secretary, Canterbury Group Hospital Management Committee, St Martin's Hospital, Canterbury

Professional Engineers in many departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W 1, quoting No 3225

Research Assistant (Biological) (with degree in subjects including physiology or zoology)—The Professor of Chemical Pathology, Westminster Medical School, 17 Horseferry Road, London, S W 1

Research Chemist in connexion with the study of problems of fruit and vegetable preservation—The Director, Research Station (University of Bristol), Campden, Glos

Research Chemists—The Secretary, British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey

Research Fellows in Climatology (open especially to graduates in botany and agronomy) and Physiography (open to graduates in geology, soils and geography)—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada

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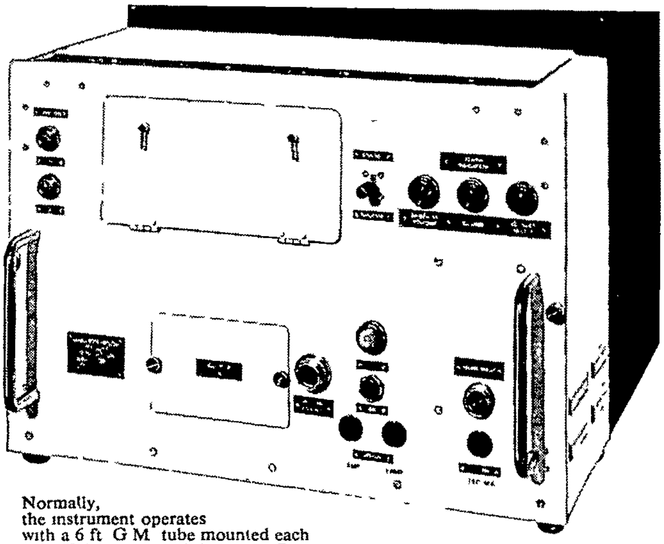
Research Physicist for work in South Wales on bio-physical factors concerned in clinical radiography—The Director, Pneumoconiosis Research Unit, Llandough Hospital, Cardiff

Sanitation Engineer in the Works and Hydraulics Department, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27322/130

Senior Lecturer in Physiology—The Dean of the Medical College, St Bartholomew's Hospital, West Smithfield, London, E C 1

Water Engineer in the Public Works Department, St Kitts-Nevis—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27329/37/50



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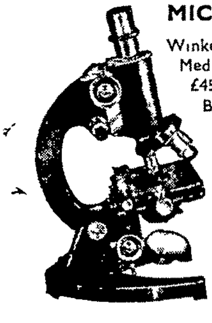

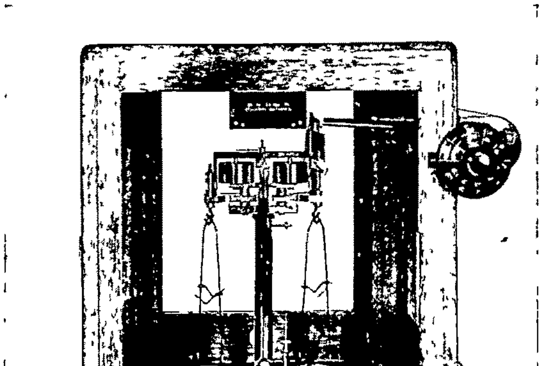

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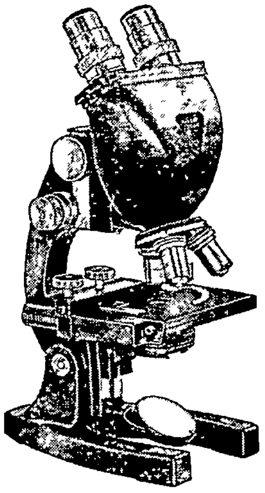

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# NATURE

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# SIGNIFICANCE OF TECHNICAL EDUCATION

REFERENCE has already been made in these columns (*Nature*, October 21, p 661) to some points in the two reports dealing with technological and technical education and man-power in Great Britain which have been prepared by the Parliamentary and Scientific Committee Other aspects considered also merit attention The Committee suggests that an increased technical element in secondary education is needed, and that the number of secondary technical schools should be greatly increased A great expansion of the opportunities in secondary modern schools for education with a technical bias is recommended as one of the most urgent tasks of the Ministry of Education Increased provision of courses of a more practical nature in technical colleges, particularly part-time courses, is also needed, and such courses should lead to the award of certificates of the City and Guilds of London Institute in a large number of crafts and industries Moreover, a detailed study of regional and local industrial needs is desirable before the Minister issues instructions to local education authorities to establish and maintain county colleges in accordance with the Education Act of 1944 The functions of these colleges in providing part-time day courses for those in the age-group 15-18 may to some extent overlap those of existing technical colleges

The report on technical education and skilled man-power, however, scarcely does justice to the development of part-time release from industry for attendance at technical colleges to which the last report of the Minister of Education testified, and while it is true that close co-operation and understanding between employers, employees and technical colleges are essential to produce the results, the Parliamentary and Scientific Committee in this report does not seem to get to grips with the real problem of how the standard of technical education is to be raised and the technical colleges enabled to concentrate on their task of training the technicians, undistracted by that of training the technologists

Many of the other recommendations of the Committee are unexceptionable , for example, it is true that more industrial firms must accept their responsibility for producing skilled craftsmen, by giving training in the technique of the various trades and in the manipulation and use of the necessary hand and machine tools They must also develop a better organised system of practical training and apprenticeship schemes, which may include education at works schools which should be combined with education at technical colleges

What is imperative, however, is the need for some reconsideration of the respective functions of the technical colleges and the colleges of technology, and of the quantitative contribution both have to make Without an idea of the ratio to be established, we cannot hope to deal effectively with the further question of staffing the colleges The Parliamentary and Scientific Committee does, indeed, note a tendency for apprentices and other young workers, particularly in the engineering and building industries, to embark on national certificate courses, although they would gain much more benefit from a course leading to the award of a City and Guilds craft certificate Far more important, however, may be the effect on the national interest of drawing away the young craftsman from the craft side of such industries into the drawing office and administrative side, with distortion of the balance desirable from the point of view of productivity and industrial development

The seriousness of this tendency, under present conditions, should be the more apparent when it is viewed against a wider background In a recent article in the *District Bank Review*, Mr K S Lomax gave some figures to show that in twenty-two industries the proportion of administrators, technicians and clerks to operatives has, on an average, about doubled in the past forty years, and in most industries the proportion of staff to workers has risen two, three or four times as fast in the last decade as it did for thirty years before Mr Lomax's figures tend to slur the distinction we have just been stressing between technologist and technician, and it is by no means clear in his figures into which group the craftsman falls Nevertheless, when all allowance is made for the fact that technologists themselves should be ranked as productive as well as the technician, and for the natural influence of increased mechanization in some industries, Mr Lomax has directed attention to a disturbing factor which not only hampers productivity but also must be taken fully into account in framing any policy of technical education

Whatever industry can do by way of training its recruits will, in fact, be of slight importance unless the educational policy pursued by the Government—and probably also its general fiscal and industrial policy —is one calculated to check such distortions Every reasonable opportunity and encouragement must be given to the exceptionally gifted to enable them to qualify for higher positions by further training at a university or college of technology, but provision must also be made for the technical training and skill which are within the capacity of the average individual and which are required by industry in its recruits The lead must come from the top

That is equally true of the question of staffing schools, technical colleges and colleges of technology Sir Ewart Smith remarked, in his paper before Section L (Education) of the British Association, on the growing unbalance between the rewards offered in industry and teaching, and the way in which numbers and quality of men offering themselves as science teachers in the schools are decreasing when the national interest requires an upsurge The Parliamentary and Scientific Committee in its first report recognized the dependence of the quality of the staff obtainable for colleges of technology upon the salaries offered and the conditions of service, and urged the Minister of Education to invite the Burnham Committee to make provision for special scales to meet the situation in selected departments of colleges of technology In this it is supported by a passage in the third report from the Advisory Council on Scientific Policy

In its second report, also, the Committee urges on the Ministry of Education that improved recruitment to the full-time teaching staffs of the technical colleges can only be obtained by improving the salary and superannuation conditions sufficiently to attract teachers with experience and qualifications which would bring them advancement in industry, and to facilitate interchange between college and industrial staff That condition may well be even more important in the technical colleges than in the colleges of technology, but in neither sphere can the extension of the practice of industrial firms allowing qualified men on their staffs to act as part-time day teachers make more than a minor contribution towards alleviating the present shortage The proper use of such part-time teachers appears to lie rather in the teaching of special highly technical subjects, when the pace of advance necessitates teaching being given from within the industry and is accordingly most appropriate for advanced lectures in the colleges of technology, as indeed was suggested in the Percy Report

The dependence of the economic position of Great Britain upon technical education in its broadest sense is made sufficiently plain in these reports and in Sir Ewart Smith's paper The Parliamentary and Scientific Committee's reports further indicate certain ways in which industry could improve the position, and they give a clear lead also to professional bodies They indicate, too, the vital part which the Ministry of Education has to play and the importance of giving that Ministry the power and resources to ensure that over the whole country technical education is raised to, and maintained at, the highest possible standard It is to be hoped that the Parliamentary and Scientific Committee will examine further the question of keeping technical education quantitatively in balance with technological education, and the latter with university education, and all three in some reasonable relation to the nation's estimated resources in man-power and woman-power, its reserves of talent and its needs for trained men and women at all levels and on all sides of national work

Such questions are well within the competence of that Committee, but the question of dealing with those psychological factors which hinder the full utilization of technical development and invention, or which tend to deflect the craftsman or technician away from the workshop or factory, where the national interest demands his services, to the office or other non-productive posts which carry at present more social prestige, is a much wider one If here again Government policy might do something to give a lead, the fundamental requirement is a sustained educational policy directed to create an informed public opinion and to correct the social values which are responsible for the undesirable differentials in status Government policy and action, in education and in other fields, are important in determining the distribution and magnitude of technical skill and craftsmanship and the efficiency of industry The full realization of the benefits which the wider and earlier application of scientific discovery and technical invention could bring to industry and to the nation as a whole does not, however, entirely depend on Government policy and on fiscal, economic or technical factors. It depends equally on a spirit of co-operation and a receptivity to new ideas in the rank and file of industry as well as in its leaders; and it is for the scientific worker and technologist to play his own part as a citizen in the formation of the public understanding and goodwill in which such co-operation and receptivity flourish.

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# SCIENCE THROUGH THE POET'S MIND

## Science and English Poetry

A Historical Sketch, 1590–1950. By Douglas Bush. (Patten Lectures, 1949, Indiana University.) Pp. ix + 166. (New York and London: Oxford University Press, 1950.) 16s. net.

THE book under notice being a very personal one, a personal note may perhaps be permitted in this review. Accordingly I will confess that the name of Prof. Douglas Bush was unknown to me when I took up "Science and English Poetry", although I have since found that this is not an admission that does me credit. Having in the past received the impression that many—or, say, some—of those who write professionally of poetry rather dislike it, although they find it an apt subject for a display of arid learning; having found that they sometimes write a rather turgid and troublesome English and, further, that they, in general, know nothing of science, it was with no very lively anticipation of pleasure that I began my reading. Let me say at once that I was speedily won over by the author. It is clear that, in spite of his very extensive reading and his professional concern, he has a strong liking for poetry; he writes a simple, charming and direct style, enlivened by a polished irony; he knows quite enough of science for his purpose—although he twice seems to imply that universal gravitation and terrestrial magnetism are much the same thing.

And what is his purpose? To trace the influence of the main developments of scientific thought and discovery on the English poets; to analyse the attitude of poetic minds, engaged in contemplating the problems of man's nature, destiny and environment, towards the findings of the natural philosophers. Beginning with the Elizabethans, he points out that the work of Copernicus and Tycho Brahe had little influence on Shakespeare and his contemporaries; in fact, it is probably true that, for the active intelligences of the England of the sixteenth century, experimental and observational science had about as much authority as poetry has to-day for the leaders of thought. The Elizabethan poets were content with the medieval scheme of things. Later, Donne's writings show from time to time an imagery borrowed from contemporary science, while Milton had, perforce, to busy himself with astronomical exposition through the mouth of Raphael and in such passages as that leading up to the Paradise of Fools—

"They pass the Planets seven, and pass the fixt,
And that Crystalline Sphear whose ballance weighs
The Trepidation talkt, and that first mov'd; ..."

The poet's general attitude is, however, summed up at the beginning of "The Argument" to Book VIII: "Adam inquires concerning celestial Motions, is doubtfully answer'd, and exhorted to search rather things more worthy of knowledg".

It was with the spread of a knowledge of Newton's work that scientific thought became a real influence on contemporary poetry. Apart from the impression which Newton's individual discoveries made on the poets, a subject to which Marjorie Nicolson's recent book "Newton Demands the Muse" directed attention, for most eighteenth-century minds Newton was the man who revealed order and design, of divine origin, running through all creation. Newton himself said in the "Principia"*: "This most beautiful System of the Sun, Planets and Comets, could only proceed from the counsel and dominion of an intelligent and powerful being. ... And from his true dominion it follows, that the true God is a Living, Intelligent and Powerful Being; and from his other perfections, that he is Supreme or most Perfect". This was the general implication that James Thomson, for example, saw in Newton's work, and Young, of the famous "Night Thoughts", likewise saw devotion as the daughter of astronomy. The romantic revolt of the early nineteenth century, of Coleridge and Wordsworth and Keats, was, then, as the author says, a revolt against a misinterpreted Newton, against the purely mechanistic and material scheme of things which so incensed Blake—who, it is safe to conjecture, never read the "Principia" or the "Opticks".

In the nineteenth century evolution was the scientific theme that imposed itself upon the intelligent world as much as Newton's discoveries did in the eighteenth. Tennyson pondered profoundly upon the meaning of this doctrine for man's spirit. Before Darwin's "Origin of Species" appeared, Lyell's "Principles of Geology" and Chambers's "Vestiges" had already contended that natural law had governed the changes that had taken place in organic and inorganic Nature since the creation, and "In Memoriam" contains in moving poetry the struggle of the poet's mind between faith and despair. "Shall man," he asks,

"Who trusted God was love indeed
  And love Creation's final law—
  Tho' Nature, red in tooth and claw
With ravine, shriek'd against his creed—

* * *

Who loved, who suffer'd countless ills,
  Who battled for the True, the Just,
  Be blown about the desert dust,
Or seal'd within the iron hills?"

It must here be admitted that Prof. Bush appears to consider Tennyson to be a very fine poet, even better than the great poets of to-day, although, unlike most younger critics, he has read both, which is always liable to warp the judgment. In his last chapter he deals as sympathetically as may be with the modern poet, the "detached, isolated, hostile observer of society". He helpfully analyses present tendencies: "we must," he says "distinguish, if we can, between authentic obscurity and mere fashion; and—though it is not correct to say so—I think we must make a parallel distinction between authentic pessimism and a fashionable cult of despair", and, after discussing Mr. T. S. Eliot, "For the modern recognition man's plight has led in two opposed directions, to pleas for more science (and more social science) and to a religious revival" He bravely endeavours to do the right thing by Mr Auden and Mr Eliot

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* Motte's translation, 1729.

There can be no doubt of the accomplishment, the charm of style and the interest of this book The author is sometimes controversial I am always on his side, but then I share Prof Bush's admiration for Tennyson (no, we do not consider "The Idylls of the King" typical Tennyson) and am gratified to find cited Burton's "Anatomy of Melancholy", Drummond's "Cypress Grove", Robert Benchley and other favourites of mine All those who concern themselves with the fluctuations in the attitude of intelligent minds to the fundamental problems of man's relation to Nature should read this book, even if they are indifferent to, or dislike, poetry But they will get more out of it if they have a taste for poetry

E N DA C ANDRADE

## PHOTOELASTICITY

### Photoelasticity

By Prof Max Mark Frocht Vol 2 Pp xvii + 505 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1948 ) 60*s* net

### Photoelasticity

Principles and Methods By H T Jessop and Dr F C Harris Pp viii+184 (London Cleaver-Hume Press, Ltd , 1949 ) 28*s* net

PROF M M FROCHT's book is the long-awaited second volume of his work, the first volume of which was published in 1941 It would probably be fair to say that, in contrast to the first volume, the emphasis in this book is strongly on elasticity Two-fifths of the book is devoted to a consideration of various aspects of the theory of elasticity, presented in a manner which makes the subject thoroughly palatable to the engineer, the presentation shows every sign of the wide and successful teaching experience of the author He deals specifically with stresses in semi-infinite and infinite plates, wedges and beams, and circular disks He presents in each case a detailed comparison of photoelastic and mathematical results which should convince mathematicians of the validity of the photoelastic method, and experimentalists of the accuracy of the mathematical methods

Prof Frocht has also collected together the theoretical and practical evidence which justifies the use of plastic models to predict the stresses in components made of steel or aluminium Other chapters are devoted to a discussion and exposition of the available experimental and mathematical methods of obtaining isopachic patterns The isopachics are the *contour* lines of equal sums of principal stresses, whereas the ordinary photoelastic stress pattern, the isochromatics, defines the values of the difference between the principal stresses at all points When both these patterns have been obtained, the values of the separate principal stresses can be computed

The remainder of the book is devoted to a description of the techniques of three-dimensional photoelasticity, stress-'freezing', the use of light at oblique incidence, the use of scattered light, and a brief reference to the use of convergent light An appendix contains details of the physical properties of 'Fosterite', a comparatively new photoelastic model material for use with the stress-'freezing' technique

Colonel H T Jessop and Dr F C Harris's more recent book on photoelasticity is a most welcome record of the revival of interest in photoelasticity at University College, London, where so much of the pioneer work in this subject was done in the days of Profs Coker and Filon This is a most useful textbook which provides the reader, in one volume, with the necessary elements of elasticity and optics, in the first half of the book, and much practical information on the apparatus used and the techniques employed, in the second half

A brief discussion of the theory underlying the stress-'freezing' technique makes the limitations of the method very clear by setting out the necessary conditions of symmetry which must be fulfilled if the patterns obtained are to have any value other than the æsthetical appeal of their abstract beauty There has been a good deal of confused thought on this subject, which should be clarified by the discussion in this book

A very complete chapter on the photoelastic bench is likely to prove to be the most useful to the beginner, as the difficulties encountered with different optical systems are discussed lucidly and explained in detail

E K FRANKL

## FLORA OF THE CAPE PENINSULA

### Flora of the Cape Peninsula

Edited by Dr R S Adamson and T M Salter Pp xix + 889 (Cape Town and Johannesburg Juta and Co , Ltd , 1950 ) 55*s*

THE editors, Prof R S Adamson and Captain T M Salter, together with their collaborators, have provided in this work a descriptive flora of the best-known part of Cape Colony, namely, the Cape Peninsula The area dealt with comprises 182 square miles and provides the home for an exceptionally rich flora, comparable to certain areas of Western Australia, and famous for its Ericaceous and Proteaceous shrubs

The Cape Peninsula is only about one-fifth larger than the smallest English county, which has a recorded vascular flora of less than nine hundred species But the habitats here considered range in altitude from sea-level to 3,549 ft on Table Mountain, with a long coastal margin and diversity of inland conditions, while the rainfall may be less than 20 in a year at the low levels or more than 80 in on the mountains It is true that, as the editors emphasize, the increasing population and especially the frequency of bush fires militate against the persistence of the native flora, but Table Mountain above the 1,000-ft contour and the southern tip of the Peninsula have been proclaimed Nature reserves, which, if supported by public opinion, should materially assist in preservation

The authors treat only of the flowering plants and ferns, but the total records of these number no less than 2,622 species, of which about 65 per cent are dicotyledons, 32 per cent monocotyledons, the gymnosperms account for six species and the ferns fifty-seven Dichotomous keys are provided for the genera and for the identification of the species For every species a brief description is provided, and a statement of the type of habitat, its frequency and period of bloom The proof of the utility of such keys can only be fully assessed in the field, but the provision of a glossary should render them of assistance, even to those with but a slight acquaintance with botany, and there can be no doubt that the authors have provided a work that will supply a real need.

Perusing these pages, it is of interest to note the representation of the various groups. Compositæ are, of course, by far the largest, while Leguminosæ, Iridaceæ, Cyperaceæ and Orchidaceæ follow. But the Ericaceæ are represented by one more species than the orchids, and no less than 102 are species of *Erica*. Another well-represented genus is *Oxalis*, with thirty-three species, of which all but a third are cited as frequent to very common and only two as very local and one as rather rare. The species of *Erica* afford a striking contrast; only about a quarter are frequent or common, about thirty-two are occasional, sixteen species are local or very local, and twenty-five exhibit varying degrees of rarity and seven species have already become extinct. Here the need for active preservation, before it is too late, is obvious. Of the Proteaceæ, forty-three species are recorded as belonging to nine genera, of which about two-thirds are still frequent to common, a quarter grow occasionally or only locally, while nearly a fifth are rare to very rare. The Restionaceæ and Arizoaceæ are both well represented, the latter by ninety-four species, the former by eighty-six species, of which many are only found occasionally and a number are rare.

A ten-page introduction includes an all too brief account of the habitat conditions from which the absence of any consideration of the soils is to be deplored.

The text is clearly printed and the keys are easy to consult; and, having regard to the size of the work, the price is not unreasonable, doubtless due to the assistance afforded by the South African Council of Scientific and Industrial Research and the University of Cape Town, to which, as to the authors and editors, those interested in the flora of the Cape Peninsula owe a debt of gratitude.

E. J. SALISBURY

## THE MATHEMATICS OF INTELLIGENCE

### Human Ability

A Continuation of "The Abilities of Man". By Prof. C. Spearman and Prof. Ll. Wynn Jones. Pp. vii + 198. (London: Macmillan and Co., Ltd., 1950.) 16s. net.

"HUMAN ABILITY" was designed by the late Prof. C. E. Spearman as a continuation of the "Abilities of Man", published in 1927. Of the earlier book, an anonymous reviewer (*Nature*, 120, 181; 1929) regretted that ". . . it is distinctly written for the layman, and he is expected to take many things on faith. He has to trust Prof. Spearman's mathematics and still more Prof. Spearman's arithmetic". Prof. Karl Pearson—for anonymity was no disguise, and the review is included in Morant's bibliography of his writings—was not prepared to trust either, and expressed his lack of confidence at some length elsewhere. It is to these controversies of the 'twenties that readers of "Human Ability" will find their attention often returning. It is not that later work is unacknowledged—the literature of the past twenty-five years has, in fact, been very fully ingested, if not always completely digested—but that this work is presented as a series of purely technical extensions of method and that important differences of opinion which have emerged about the status of mental factors are scarcely touched on.

Briefly, Spearman's thesis was that the uniformly positive correlations observed between different mental tests could be—and, for economy of hypothesis, should be—explained by two kinds of factor, a general factor $G$ common to all the tests, and a series of specific factors $S$, each related to a single test. Later, other factors were admitted, which were intermediate in range, being represented in several but not all of the tests. "Human Ability" is partly a recapitulation and partly an attempt to bring the story up to date, describing the development of factor analysis at the hands of Spearman and others, and replying to the various criticisms which have been raised. In the latter part of its purpose, the book is not entirely successful. It is disappointing to find the interpretation of factors considered only in a narrow sense, and the biological reference of these statistical entities dismissed as "metaphysics". Similarly, the objections considered are largely those raised by Pearson and Thomson to the original two-factor theory—not the more radical criticism which in recent years has attacked the whole conception of factor analysis. On the technical side, the book will scarcely stand comparison with the accounts given by Thomson or by Holzinger and Harman, and it has less general interest than Burt's "Factors of the Mind" or Spearman's own earlier works. For the student some introduction to the subject from other sources is indispensable before reading "Human Ability".

The defects of the book are to some extent accounted for by the fact that it was unfinished at the time of Prof. Spearman's death; and Prof. Ll. Wynn Jones, who as part-author prepared the book for publication, has treated an incomplete text with almost excessive reverence. Many parts of the book seem to lack any consecutive theme; and it is difficult to believe that the brief paragraphs on the use of matrix algebra—to take one example—were meant to be published as they stand. If the book is in places little more than a skeleton, the bones are at any rate elaborately clothed. Prof. Spearman's crusading zeal is fully evident—in his comments, for example, on the extensive use now made of mental tests. "Voices are becoming more and more insistent", he writes, ". . . that the sway of the tests must be extended over the whole national man-power, woman-power, and child-power", a situation which "would appear to be promising, but not free from danger".

Many psychologists are more impressed by the danger than the promise; but whether we agree with Prof. Spearman or not, his views have been extremely influential, and no one interested in human abilities can afford to neglect his writings. Pearson credited him with "the merit of directing attention to the subject", and it is a subject in which interest has grown continuously. Pearson's fear that Spearman's advocacy would "do more harm than good if it leads the non-mathematical psychologist to believe that the author has proved his hypothesis" has fortunately not been confirmed. Non-mathematical psychologists who have interested themselves in the theory have been as active in criticism as in acceptance; and latterly, non-psychological mathematicians have made their contribution to the debate. Both have found in Spearman's work the stimulus of a coherent theory, but neither has been disposed take much on trust.

A. D. HARR

### The Heterocyclic Derivatives of Phosphorus, Arsenic, Antimony, Bismuth and Silicon

By Frederick George Mann (The Chemistry of Heterocyclic Compounds Series ) Pp ix+180 (New York and London Interscience Publishers, Inc , 1950 ) 42*s*

THIS monograph is the first to appear of a series planned to cover the whole field of heterocyclic chemistry Its scope is limited to a few rare classes of substance, and this has made it possible to present the facts in considerable detail within the compass of a small volume

All types of cyclic compound having phosphorus, arsenic, antimony, bismuth or silicon as ring members are reviewed, but the arsenic derivatives, having been most studied, occupy two-thirds of the book The arsenic analogues of most of the familiar polycyclic nitrogen ring systems have been prepared and are here described The requirements of chemical warfare during and since the First World War no doubt gave an impetus to the study of arsenic compounds, and the sections on phenarsazine chloride and on the products of anti-lewisite reagents are noteworthy from this point of view

Although this is a highly specialized book, it contains much that is of general chemical interest In particular, a number of very interesting stereochemical studies by Mann, Turner and their colleagues are described These include the preparation of the only known stable optically active quaternary phosphonium and arsonium salts and of an active *spiro*-arsonium salt , optically active phenoxarsine and phenoxstibine derivatives which owe their dissymmetry to molecular structures folded across the middle ring , and some special cases of *cis-trans* isomerism in palladium complexes and in dihydroarsanthrene derivatives

The book is excellently produced and is generally free from errors , but a confusion has been noted in the numbering of formulæ on pp 71–72 G M B

### Atmospheric Turbulence

By Prof O G Sutton (Methuen's Monographs on Physical Subjects ) Pp viii+108 (London Methuen and Co , Ltd , 1949 ) 6*s* net

THIS monograph provides a clearly written account of the research which has been carried out during the past twenty years or so, largely in Great Britain and with Prof O G Sutton in the van, on turbulence in the terrestrial boundary layer The point of view is that of the mathematical physicist, but the mathematical equipment required of the reader is only slight

Following a general introduction and a concise statement of the observed behaviour of the lower atmosphere (vertical gradients of temperature and wind velocity, eddy velocities and surface shearing stress), the reader is introduced to so-called *K* theory, an empirical treatment based on the assumption that turbulent diffusion is analogous to molecular diffusion but with an enhanced coefficient of transfer Its limitations are quickly displayed, and the author then proceeds to show how the Prandtl–von Kármán ideas of the mixing path have been applied with some success to diffusion problems near the ground Here the author's marriage of mixing-path theory with Taylor's theorem on diffusion by continuous movement is described A final chapter is devoted to the effects of stable and unstable temperature stratifications and to natural convection

The subject as presented here is still in the empirical stage Because of its complexity, the essential physical bonds which must unite it to the basic laws of hydrodynamics and thermodynamics remain to be discovered , and if one has a criticism, it is that the author might have brought out this limitation of his treatment more clearly

### Minerals and How to Study Them

By the late Edward Salisbury Dana Revised by Cornelius S Hurlbut, Jr (Dana's Series of Mineralogies ) Third edition Pp x+323 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 24*s* net

THE fourth and most elementary of the series of text-books by J D and E S Dana, covering the field of mineralogy, was first published more than half a century ago This new revision retains essentially the characters of the first edition and remains a well-balanced introduction to the subject The usual orthodox grouping is followed chapters on crystallography and the properties of minerals lead to a systematic description of the more commonly occurring mineral species Finally come short but adequate determinative tables It is pleasing to find these tables subordinated to the description of the minerals and not, as has sometimes recently been the case, given undue prominence

In revising the book, Mr C S Hurlbut, jun , has shortened some of the introductory chapters and, in many respects a desirable change, has rearranged the description of the mineral species to follow the chemical classification—oxides, silicates, etc —rather than listing together minerals containing the same elements The volume is attractively produced and well illustrated with numerous diagrams and photographs Newcomers to the science will find it a useful and stimulating introduction

### Artificial Radioactivity

By Prof P B Moon (Cambridge Monographs on Physics ) Pp x+102 (Cambridge At the University Press, 1949 ) 12*s* 6*d* net

IT is an extremely difficult undertaking to write a hundred pages on the main phenomena and techniques of radioactivity, even if these are limited to the medium and light nuclei, as the author states in the preface The selection of what can be put of such an enormous field in such a small space must have been one of the main difficulties of the author In my opinion, this has been solved, and a small book has been created, easily understandable and giving in some places much more than the pure fundamentals

Identification and measurement of radiations and particles have been condensed into twenty pages, giving, of course, not much more than a very short description of the subjects

The main emphasis is laid on the two other chapters—on radioactive processes in which the charge of the nucleus is being changed, and such processes where the charge of the nucleus does not change In a condensed, but very clearly written, version the theories of β-ray spectra and of the electron-capture process are discussed A good balance is maintained between theoretical considerations and experimental methods and results

This is a book which should fulfil the aim to give a reader a clear short version of a number of advances in nuclear physics, without obstructing the view by insertion of too many details HENRY SELIGMAN

# THE HARWELL NUCLEAR PHYSICS CONFERENCE, 1950

TWO hundred and thirty delegates, of whom one hundred were from overseas, attended the International Nuclear Physics Conference held in the Clarendon Laboratory and Geography School lecture theatres in Oxford during September 7–13 In the five days of meetings nearly one hundred papers were given and there was much stimulating discussion both in and outside the sessions In the confines of a short article it is possible to mention but a fraction of the papers and then only very briefly

The sessions were divided into four main groups On September 7 and 8, papers were given on the construction of high-energy accelerating machines and experimental work done with them, together with experiments in the allied field of cosmic radiation The papers on September 11 and 12 were concerned with experiments at lower energies involving more modest accelerating equipment September 13 was given to 'pile' physics, and, during the course of the meetings, alternative sessions on techniques, α- and β-ray spectroscopy, neutron spectroscopy and theoretical physics were held

Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, after welcoming the delegates, took the chair for the opening session on high-energy accelerators The first paper, by Prof L W Alvarez, reviewed the machine programme at Berkeley, California, and gave some experimental results In particular, the differential *p–p* scattering cross-section has been found to have the value of 4 mB per steradian at 90° and 340 MeV , and is independent of angle and energy in the range 200–350 MeV The 60-in cyclotron has been modified by Hamilton and Miller to accelerate carbon-12 nuclei and has been used by Seaborg to produce californium-244 and -246 from uranium-238 The method will probably lead to the production of further transuranium elements

Prof P G Kruger described the Illinois betatron, which was brought into operation in February and is giving an output of 1 R per pulse, the maximum energy being 345 MeV The Brookhaven proton synchrotron ('Cosmotron') is 80–90 per cent complete, and Prof G B Collins discussed the difficulties which have to be overcome to obtain a beam

Among machines brought into operation recently, Prof E T Booth discussed the 385-MeV Columbia cyclotron, Dr U Liddel (Office of Naval Research) the 340-MeV synchrotron at the Massachusetts Institute of Technology, and Mr M Snowden the 170-MeV Harwell cyclotron At the Massachusetts Institute of Technology, experiments are planned to utilize the optical energy radiated from the accelerating electrons for studies in the region of 50–200 A , which has been neglected hitherto for lack of a suitable light source

Meson physics was introduced by Prof B J Moyer (California), who discussed the Berkeley evidence for the $\pi^0$ particle An upper limit of $2 \times 10^{-13}$ sec can be set for the half-life of the particle and, from experiments on the γ-rays resulting from $\pi^-$ meson capture in hydrogen, the mass of the $\pi^0$ meson is found to be $261 \pm 3\ m_e$ Capture of $\pi^-$ mesons in deuterium does not lead to $\pi^0$ formation but yields neutrons according to the equations

$$\pi^- + \mathrm{D} \rightarrow n + n, \qquad (1)$$

$$\rightarrow n + n + \gamma. \qquad (2)$$

Reaction (1) is twice as likely as (2)

The Bristol value for the half-life of the $\pi^0$ meson was given by Mr D T King as $3 \times 10^{-14}$ sec , and Prof G E Cosyns (Brussels) showed that in stars having more than twenty penetrating particles there is angular correlation between pairs His results suggest, he said, that both multiple and plural production of mesons occur Evidence for the *V*-mesons (both charged and uncharged) obtained by the Manchester group and by Prof Anderson's group (California) was presented by Prof P M S Blackett, who suggested tentative decay schemes

Further scattering and high-energy disintegration experiments were reported from Bristol, Harvard, Harwell and Rochester, but these will not be discussed here

The theoretical session on high-energy physics was enlivened by the challenge of the new *p–p* and *n–p* scattering data where the results are in disagreement with the theory Dr A Pais (Princeton) gave an admirable review of the position, and showed that the experiments can only be explained by introducing a strongly singular force between protons and a somewhat smaller one between neutron and proton He stated that for spin-orbit coupling he favoured the potential well

$$\varphi(r) \propto \frac{1}{r}\frac{d}{dr}\left(\frac{\exp - Kr}{r}\right),$$

which is the meson-theoretical analogue of the potential encountered in atomic theory

After a visit to the laboratories of the Atomic Energy Research Establishment, Harwell, on September 9, the week-end was taken up with social activities

The Conference resumed on September 11, when Prof T Lauritsen, after describing the machines and spectrometers in use at the California Institute of Technology, gave up-to-date level schemes for oxygen-16, lithium-7 and the interesting mirror nucleus beryllium-7, the γ-ray from the 430-keV level of which has now been observed Reactions resulting from the bombardment of fluorine by protons have received much attention in the past, but new work is still being reported Prof S Devons (London) gave results on the angular correlation between the α-particles and the pairs from the pair-emitting state of oxygen-16 which agree with Dirac theory assuming a spherically symmetrical field, and Mr J G Rutherglen (Glasgow) showed evidence for a 12-MeV γ-ray which suggests a low-lying level in the neon nucleus at 1 53 ± 0 1 MeV

An ionization chamber in which wall effects have been eliminated has been used in Heidelberg for the study of energy-levels excited by a fast neutron flux It was described by Prof W Bothe, who reported finding many new excited states of nitrogen-15 The reactions $\mathrm{O}^{16}(dp)\mathrm{O}^{17}$, $\mathrm{F}^{19}(d\alpha)\mathrm{O}^{17}$ and $\mathrm{C}^{12}(dp)\mathrm{C}^{13}$ have been used by Prof J Rotblat (London) to obtain level-schemes for carbon-13 and oxygen-17

The results show a remarkable correlation between the energy states of the two nuclei for which it is difficult to account on theoretical grounds.

The major part of the afternoon session was devoted to the study of reactions involving tritium, either as a target or a bombarding particle. Prof. T. Bonner (Rice Institute), Dr. R. F. Taschek (Los Alamos Scientific Laboratory), and Mr. M. J. Poole (Harwell) have all investigated the energy-dependence of the cross section for the $D(Tn)He^4$ reaction. It has a maximum value of about 5 barns in the region of 180-keV triton energy. Mr. B. H. Flowers (Harwell) showed that strong spin-orbit coupling is necessary to account for such a large cross-section, and the calculated energy-dependence agrees with the experimental results if the accurate wave-functions of the Coulomb field are employed. Los Alamos experiments on the reactions $T(pn)He^3$ and $T(p\gamma)He^4$ suggest the existence of a helium-4 level above 20 MeV. The T–T reaction, among the possible products of which are the dineutron and helium-5, is being studied at Los Alamos and Chalk River, but the experiments do not allow definite conclusions to be drawn at present.

A paper on $(p\gamma)$ coincidence experiments using scintillation detectors having high resolution was given by Dr. W. E. Burcham (Cambridge). Applied to the reaction $B^{10}(dp)B^{11}$, counting-rates as high as 10 coincidences per microcoulomb of deuterons have been obtained.

The morning session of September 12 on angular distribution experiments and their interpretation was introduced by Prof. D. R. Inglis (Argonne National Laboratory), who outlined the theory with particular reference to the reactions $Li^7(p\alpha)He^4$ and $Li^6(d\alpha)He^4$. Analysis of these reactions shows that parities deduced from the nuclear models are correct; but disappointment was expressed that most of the information obtained relates to the highly excited state of the compound nucleus, which is in a region too complex to be treated theoretically. In a review of $p$–$p$ and $n$–$p$ scattering experiments in the region up to 30 MeV., Prof. J. H. Williams (Minnesota) showed they can be interpreted assuming that the purely nuclear scattering occurs only in states of angular momentum zero. Recent Minnesota experiments demonstrate that, in the region below 5 MeV., the 'effective range' between nucleons is independent of charge.

Dr. H. Wäffler (Zurich) described measurements of the separate angular distribution of the lithium 17.6- and 14.8-MeV $\gamma$-rays, from which he concluded that the 17.6-MeV. level of beryllium-8 has even parity and odd angular momentum. Prof. P. Huber (Basel) discussed an experiment on the differential scattering cross-section of neutrons of about 3 MeV. energy by carbon, nitrogen and oxygen nuclei.

Related papers on the angular distribution of neutrons and protons from $(dn)$ and $(dp)$ reactions were given by Dr. J. Holt (Liverpool), who showed that there is a strong forward peak in both types of reaction, and by Prof. Rotblat, who has examined the angular distribution of the protons in $(dp)$ reactions for various states of the final nucleus. The theory of these processes was treated by Mr. S. T. Butler (Birmingham), who showed how the angular distributions can be used to give the spins and parities of the nuclei involved. He invokes a stripping process and, by inserting certain boundary conditions, can predict the angular distributions to be expected for various values of spin and parity of the state of the final nucleus when these properties are known for the ground-state of the target nucleus. As an example he found from the experiments that the ground-state of oxygen-17 should be a $D_{3/2}$ or $D_{5/2}$ state.

The afternoon session on photodisintegration experiments was largely devoted to experiments with the deuteron. Dr. H. von Halban reviewed recent work in Oxford which still shows discrepancies with theory, and Dr. D. H. Wilkinson described Cambridge experiments with $\gamma$-rays extending from 4 to 17.6 MeV. and which lead to a value of the triplet range in good agreement with the figure reported later by Dr. Hughes. The disintegration $C^{12}(\gamma 3\alpha)$ was described by Dr. V. Telegdi (Zurich), who found that, after going through a maximum at 18.5 MeV., the cross-section rises again as the energy is increased to 32 MeV. Mr. F. K. Goward (Harwell) discussed work on the reaction $O^{16}(\gamma 4\alpha)$, which proceeds either as a $(\gamma\alpha)$ reaction via an excited carbon-12 nucleus or as a fission-like process in which the oxygen nucleus breaks into two beryllium-8 nuclei. A new reaction, $Li^7(\gamma T)He^4$, was reported by Dr. E. W. Titterton (Harwell), who gave a value for the cross-section of $1.2 \pm 0.6 \times 10^{-28}$ cm.$^2$ at 17.6 MeV., and showed an excitation function indicating that the cross-section has a maximum value in the neighbourhood of 14 MeV.

The 'pile' physics sessions on September 13 were more concerned with research done with neutron beams than with the physics of piles. Dr. R. E. Bell described the Chalk River heavy-water pile, the neutrons from which have been used to excite $\gamma$-rays from neutron capture in hydrogen. From a measurement of their energy, the binding energy of the deuteron was found to be $2.230 \pm 0.007$ MeV., which is significantly higher than earlier values. The elegant experiments of J. M. Robson demonstrating the $\beta$-decay of the neutron were given detailed treatment. An allowed spectrum is found, the end-point being at 782 keV. Dr. D. J. Hughes described the Argonne 300-kW. pile and the newly completed Brookhaven 30-MW. pile. A high-speed mechanical chopper will be used with the latter for neutron time-of-flight experiments over a path-length of 20 metres. The device is expected to give a resolution ten times better than that of any previous chopper. Slow-neutron scattering experiments have allowed determination of the nuclear interaction triplet range as $1.74 \pm 0.1 \times 10^{-13}$ cm. and the singlet range as $2.6 \pm 0.5 \times 10^{-13}$ cm.

The Oak Ridge pile has been used for experiments on neutron diffraction and the decay of the neutron. Dr. A. H. Snell reported on both and gave scattering cross-sections and scattering efficiencies for various nuclei as measured by Wollan and Shull. At Los Alamos, the water boiler and fast reactor both operate at 10 kW. and give $10^{11}$ (slow) and $5 \times 10^{12}$ (fast) neutrons/cm.$^2$/sec. respectively. After describing them, Dr. D. K. Froman discussed a proposed experiment to investigate the angular distribution of neutrons scattered by liquid helium II which, it is expected, will determine the statistics of the scattering nuclei.

Pile modulation techniques for cross-section measurement were discussed by Mr. D. J. Littler (Harwell) and Dr. L. Kowarski (Paris); and a stimulating paper on neutron beam magnetic resonance experiments was given by Prof. N. F. Ramsey (Harvard), who is currently using the method to determine the electric dipole moment of the neutron and the neutron magnetic moment. Fission physics were treated in three papers: the first by Dr J. C. Jacobsen (Copenhagen) on the fluctuations of charge on the fission fragments, the second on rare modes of fission by Dr E. W. Titterton (Harwell) and the last, by Mr J. Scott (Cambridge), on the theory of the fission process.

β-ray spectroscopy was treated in an alternative session. Dr K. Siegbahn outlined the work in Stockholm on the internal conversion coefficients of certain isomeric transitions; he finds the results to be compatible with those expected on the shell model. Dr H. O. W. Richardson described the spectrometers in use in Edinburgh, and Dr S. C. Curran gave details of experiments in Glasgow, using proportional counters placed in a magnetic field, to examine β- and γ-ray spectra up to an energy limit of 2 MeV. Work at Harwell on gold-198 was reported by Dr P. E. Cavanagh, and an experiment determining the internal conversion coefficient of an isomeric transition in bromine-82 was described by Mr D. West. In the field of α-ray spectroscopy, experiments reported by Dr S. Rosenblum (Paris) provided information on the nuclear radii of the $4n$, $4n + 1$ and $4n + 3$ radioactive series.

The neutron spectroscopy session included discussion of three types of time-of-flight spectrometer: the direct method of the mechanical modulator ('chopper') was described by Dr Hughes; the modulated cyclotron, typified by the Columbia installation, was discussed by Prof. W. W. Havens, who also reported a new measurement of the electron–neutron interaction potential as 5,000 ± 1,000 eV; and Mr A. W. Merrison discussed the Harwell equipment which employs a pulsed linear electron accelerator as a photo-neutron source. In addition, papers were given on neutron diffraction by Prof. K. Lonsdale (London), Dr D. G. Hurst (Chalk River) and Mr G. E. Bacon (Harwell).

The theoretical physics session was devoted to discussion of possible models of nuclear structure and their mutual relation. Prof. R. E. Peierls (Birmingham) explained some of the difficulties confronting the 'compound nucleus' picture, formulated first by Bohr; Prof. E. Wigner (Princeton) outlined the evidence which produced the concept of 'magic numbers', and the shell-structure models of the nucleus which have been suggested to explain these numbers; Prof. Inglis reported further work on the *j*-*j* coupling model. Prof. Peierls also directed attention to recent significant experiments at Chalk River by Kinsey *et al.*, which showed that some heavy nuclei have entirely unexpected properties more characteristic of simple light nuclei. There was considerable discussion on the relation of the shell-structure model to other models, and on the extent to which it might be explained by current ideas on nuclear forces, or whether new ideas had to be introduced to explain observed regularities. Prof. P. A. M. Dirac (Cambridge), outlining his new ideas in field theory, was of the opinion that a new fundamental concept is needed, and suggested it is more likely to be forthcoming as a result of studying particles about which we know most, such as photons and electrons, rather than the more obscure mesons.

The Conference dinner, presided over by Lord Cherwell, was held in the Great Hall of Christ Church on September 12, and was notable for fine after-dinner speeches by Sir John Cockcroft, Prof. S. K. Allison (Chicago) and Prof. Niels Bohr (Copenhagen).

E. W. TITTERTON

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# THE CONCEPT OF CULTURE

VERY appropriately, the proceedings of Section H (Anthropology) of the British Association began on August 31 at Birmingham with a discussion meeting on the concept of culture. This concept has recently acquired a somewhat indiscriminate currency among anthropologists, archæologists, psychologists and other social scientists. It has dominated the development of anthropology ever since Tylor, with a stroke of genius, borrowed the term 'culture' from German scholars and generalized it to include "that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society"[1]. It has also remained the main link between the different branches of anthropology and allied disciplines as these have become more specialized in methods and subject-matter.

The meeting was opened by Dr Phyllis Kaberry (University College, London) with a paper on the recent history of the concept in British anthropology. She pointed out that since Tylor's day social anthropology has been defined as the science of culture, a term covering the whole way of life of an aggregate of people inhabiting a particular locality. Artefacts, ideas, institutions, and modes of organisation in social and political groupings are all included in culture, which, as Tylor implied, constitutes a system of interrelated parts. This idea lay behind the crucial change which occurred at the beginning of this century when anthropologists turned from tracing hypothetical origins and evolutionary stages to intensive field studies of existing cultures viewed as complex functioning wholes. Malinowski and Radcliffe-Brown had exceptional influence on this development in Great Britain; and it is significant that up to about 1931 they appeared to have a common approach. Both described social anthropology as the study of culture, their major contribution being their emphasis on culture as "an integrated system"[2] and their insistence that customs, institutions, etc., must be explained, not by conjectural history, but by the part they play "within an integral system"[3]. The principles and concepts put forward by them has determined the type of field-work done by British anthropologists since 1920. The monographs of professional social anthropologists in the intervening years are not only rich in detail but also provide analyses of the nature and function of particular institutions in selected societies within the framework laid down by Malinowski and Radcliffe-Brown. Even recent work avowedly concerned with clarifying the concept of social structure must, from this point of view, be regarded as an important contribution to our understanding of culture.

But this work, continued Dr Kaberry, is also a sign of a shift which gives cause for apprehension. A first break with the accepted view came when Malinowski himself, in 1931, outlined the theory later elaborated in his posthumous book, "A Scientific Theory of Culture"[4]. He now defined culture as "an instrumental reality which has come into existence to satisfy the [biological] needs of man", and for his former sociological definition of "function" substituted one in terms of the satisfaction of primary or derived needs. Obviously, biological, psychological and environmental factors enter as determinants the universal occurrence of many social institut but in Dr Kaberry's opinion social anthror must stick to its own conceptual tools in analysing social phenomena.

A different shift was expressed by Radcliffe-Brown in 1940[5], and afterwards. He now defined social anthropology as the "study of human society", of the "network of social relations" which make up "the social structure", and distinguished it from the study of culture, by which he appears, at present, to mean standardized, socially transmitted patterns of behaviour. The problems raised by this distinction are being keenly debated among social anthropologists. But, Dr. Kaberry concluded, its validity remains open to question. She preferred to retain the concept of culture to cover the whole way of life of a people, including their values, norms of conduct and principles of social organisation.

Dr. Glyn Daniel followed with a paper on the use of the concept of culture in prehistoric archæology. In the nineteenth century, prehistory was dominated by a geological approach and used the epochal ideas of the geologists as its main conceptual tool. Stratigraphy became the key to archæology, and a unilateral sequence of periods was devised. This rigid geological approach broke down at the turn of the century due to the realization of its inadequacy and to the influence of the culture-historical school of German anthropologists and geographers. At the present time the idea of culture is used in two senses in prehistoric archæology: first, that of the culture of prehistoric man which it studies; and secondly, that of the division of the remains of prehistoric man into separate cultures recognized by the distribution of artefact patterns in space and time. In both usages the prehistorian comes up against the difficulty that he is, in the main, studying material culture; he can make very few legitimate inferences about the social, moral and spiritual culture of prehistoric man. But bearing in mind this limitation, it is reasonable for the prehistorian to talk of the culture of prehistoric man. Dr. Daniel argued that it might not be reasonable to use "culture" in the second or partitive sense to call the persistent associations of artefacts "cultures", and he quoted some prehistoric "cultures" that are defined on one or two artefacts only. A new nomenclature in prehistory—not derived from geology, history or anthropology—is, he thinks, much overdue, and in this nomenclature some new words should be found for these artefact patterns. He discussed briefly the recent American suggestions for replacing the word 'culture' in prehistory in its partitive sense.

Mr. E. L. Trist then presented the point of view of a social psychologist. In the study of inter-personal and inter-group relations in our own society, he said, both a concept of culture and one of social structure are necessary. Though the psychologist begins with 'people', as individuals or as members of groups, and the anthropologist with the social structure, they have common problems which provide a basis for the establishment of complementary insights. To introduce more general points, Mr. Trist outlined some observations arising out of a study of the longwall method of coal-getting. The complete task is spread over three shifts and different skill groups. The methods and conditions of work, though apparently excellent production engineering, tend to make each man an isolate. Paranoid phantasies, anxiety conditions associated with absenteeism, suspicion and intrigue, are generated. Why such a system has worked so long is a problem. Habituation and the compensation of being able to project one's own hatred into the hated system play a part. This example shows how psychological forces, both at the level of the group and at that of the individual, interact with cultural and structural forces to bring about a total but concrete 'field' with a dynamic pattern. The concept of culture enables the psychological and sociological constructs used in such a situation to be brought together. Such a concept, by contrast with that of social attitude[6], can be used for all psycho-social processes.

Comparing the two major conceptual schemes which have prevailed in the human sciences, Mr. Trist pointed out that the first, the concept of a psycho-physical system, utilized, for example, in *Gestalt* psychology and in psycho-analysis, is essentially non-social; whereas the second, that of the institutional system, is non-psychological. The concept of a psycho-social system brings in cultural phenomena as techniques in means-ends relations, including skills, attitudes and action systems of an emotional order. Cultural objects may be defined as artefacts external to the individual; and cultural patterns as internal—that is, persons and groups actively use them to take roles and make relationships in the institutionalized social system. Though they may be standardized, they also refer to unconscious internal objects from which influences act on to more conscious levels and so on to society. The concept of culture is essential to relate the psycho-social patterns carried by the individual to the institutions of society.

The general discussion which followed was introduced by Prof. M. Fortes. It is, he said, reassuring to find agreement between a social anthropologist, a prehistorian, and a social psychologist that the concept of culture is indispensable for the human sciences. The reaction among some anthropologists against its uncritical use has, nevertheless, been salutary. Field experience and comparative research have shown that what Rivers called 'social organisation' can be abstracted for analysis from the total way of life of any community. A number of general principles have, for example, been shown to hold for kinship systems irrespective of the specific customs, beliefs and values in which they are expressed in particular societies, as well as of technology and economy. The concept of social structure epitomizes this advance in theory. This enables us to reserve the term 'culture' to describe what is qualitatively distinct in the way of life of one community as compared with another. To get beyond mere description in the study of culture is as much a problem of psychology as of anthropology, and the approach suggested by Mr. Trist seems full of promise.

Mr. Miles Burkitt contended that a geological basis is fundamental for prehistory. It is essential, for the next fifty years, to collect the facts in their geological setting; the connexions between 'stages' can be threshed out later. Differences between contemporaneous and apparently alike 'cultures' are obscured through the loss of artefacts. The value of the idea of culture to the prehistorian is that it brings in the people who made the artefacts. He should remember that very different cultures may be concerned with the same things. Human life even in prehistoric times was very complicated. Ultimately, culture has a biological basis related to such facts as the orientation given to individuals by environment. Starting with the individual organism, there are various degrees of individuality. The highest degree is that of society, and culture is the expression of this.

Prof. Gordon Childe, though in agreement with Dr. Daniel's criticism of the use of the term 'culture', maintained that archæologists should study what anthropologists include under this concept. Artefacts are the fossilized remains of cultures such as can still be observed by anthropologists, and symbolize patterns of behaviour learnt within social groups just as language and custom is learnt. Though much is missing, an attempt can be made to reconstruct these behaviour patterns. But we have still to face the full difficulties of the concept. Culture conditions values and categories. The good, the true and the beautiful are relative categories given by society. We are bound to the frame of reference derived from our own culture and we are unable to get outside of it.

Lord Raglan brought the discussion to a close. He disagreed with the view that any culture is a unified whole. The customs, beliefs, artefacts, etc., making up a culture are always derived from many sources. Each element can only be understood if its history is traced. An institution like monarchy, for example, can only be understood by means of hypothetical history.

M. FORTES

[1] Tylor, Sir E. B., "Primitive Culture" (London, 1871).

[2] Radcliffe-Brown, A. R., "The Present Position of Anthropological Studies", presidential address, Section H, British Association for the Advancement of Science, 1931.

[3] Malinowski, B., art. "Anthropology", *Encycl. Brittanica*, supp. vol. 1 to 13th edn., 1926.

[4] Malinowski, B., "A Scientific Theory of Culture" (Chapel Hill, 1944).

[5] Radcliffe-Brown, A. R., "On Social Structure", *J. Roy. Anthrop. Inst.*, **70**, 1 (1940).

[6] Thomas, W. I., and Znaniecki, F., "The Polish Peasant in Europe and America", 5 vols. (Chicago, 1918–20).

# THE NERVE FIBRE: STRUCTURE AND FUNCTION

ON September 5, during the Birmingham meeting of the British Association, Section I (Physiology) held a discussion on the nerve fibre. Those taking part were Prof. J. D. Boyd (London Hospital), Mr. A. L. Hodgkin (Cambridge) and Dr. F. K. Sanders (Oxford).

In introducing the discussion, Prof. J. D. Boyd pointed out that the vertebrate peripheral nerve fibre is a composite structure. It consists of an axial core of protoplasm, which is an outgrowth of a nerve cell, and an ensheathing apparatus of greater or lesser complexity and which includes the sheath cells of Schwann and a variable number of additional, cylindrically arranged membranes, the precise nature of which is in some doubt. The structure of the axial core, or axon, was then discussed with special reference to its surface membrane (the axolemma, which has peculiar and most important physicochemical properties) and the problem of the presence or absence of a fibrillar apparatus. Attention was directed to the recent work of Young and of Weiss, which suggests a slow turgor flow down the axon from the nerve cell-body. The enormous discrepancy between the volume of the axon and the volume of the nerve cell-body was emphasized, and it was indicated how this entailed some special mechanism for maintaining the integrity of the peripheral parts of the axon. The structure of the Schwann cells and of their relation to the axon was then discussed, and attention was directed to the work of Abercrombie and Johnston, which indicates some special affinity between the axon and the sheath cells. Surrounding the sheath cells is a collagenous and reticular cylindrical sheath, the neurolemmal or endoneural tube. This may be only the innermost layer of the fibrous tissue sheaths of the nerve. It has, nevertheless, important functions, more particularly in nerve regeneration. The connective tissue sheaths themselves have an importance in the study of nerve conduction, for in whole-nerve preparations they may distort potentials considerably.

Finally, the nature and structure of the myelin sheath and its segmental arrangement, with the resulting nodes of Ranvier, were discussed by Prof. Boyd. The recent work of Huxley and Stampfli has demonstrated that, in myelinated fibres, the impulse probably passes, in a saltatory fashion, from node to node. A possible objection to this concept is the absence, frequently mentioned, of nodes in the central nervous system. Central nodes, however, have been described by many of the older investigators, and recently, using methylene blue, Allison, Feindel and Weddell and Hess and Young have verified their presence. Prof. Boyd stated that in osmic and silver preparation he has never observed typical central nodes. However, he showed lantern slides in which node-like appearances were present. His conclusion is that the available evidence indicates the presence of functional nodes in the myelinated fibres of the central nervous system, but that more work is required to establish the details of their structure and arrangement.

Mr. A. L. Hodgkin commenced his account of nervous conduction by pointing out that the problems involved have been studied by physiologists and physicists for more than a hundred years. At an early stage of these investigations it became evident that the passage of 'messages' along nerves is accompanied by an electrical change called the action potential. Subsequent study has shown that electric currents play an essential part in the process of nervous conduction. The investigations of a number of physiologists, notably Prof. E. D. Adrian, have established the fundamental facts relating to the behaviour of the action potentials in intact nerves and nerve fibres during their activity. Mr. Hodgkin discussed this behaviour with special reference to the amplitude and frequency of the electrical changes and to the velocity of their conduction along the nerve fibre. He indicated how fundamental such studies are in the study of nervous activity. By accepting the nervous impulse as a biological entity, and studying it as such, physiologists and neurologists have a basic technique at their disposal for the investigation of the nervous system as a whole and in relation to general bodily activity.

There is, however, another series of problems relating to nervous activity which can only be studied by concentrating on the individual nerve fibre in an attempt to explain the nature and mechanism of the nerve impulse itself. These problems are essentially physical and physico-chemical in nature, and can only be studied adequately by the utilization of new physical methods; these methods, however, make study of the problems none the less reputable. Mr. Hodgkin then discussed the nature of the action potential and how it can be studied. He directed particular attention to the contribution that has been made by Prof. J. Z. Young in introducing the giant axon of the squid to the field of experimental physiology. He then described how the resting potential of the surface membrane in these axons can be measured by the introduction of capillary electro into their cut ends, care being taken not to touch the inner surface of the membrane. In the study of the surface membrane of muscle, which has many fundamental features in common with the corresponding membrane of the nerve fibre, Gerard and his collaborators have shown that an electrode can actually be inserted transversely through the membrane without interfering with its activity, provided that the tip of the electrode measures less than 0 5 $\mu$

Study of the action potentials in these ways has shown that they are developed at the surface membrane In the resting state (squid giant axon) the transmembrane potential difference is some 50 mV , the interior being negative During activity this potential difference alters and the interior reaches a peak of some 40 mV positive to the external solution Hence the total excursion is about 90 mV The electrical changes are associated with a remarkable series of permeability changes involving in particular the ions of sodium and potassium In the resting state there is a high concentration of potassium ions within the membrane and a high sodium-ion concentration external to it During passage of the nerve impulse the membrane permeability alters, so that sodium ions enter the fibre and potassium ions leave After passage of the impulse the resting-state conditions are restored by a secretory process which uses metabolic energy to pump out sodium and reabsorb potassium Evidence was discussed which indicates that it is the interchange of the minute amounts of sodium and potassium ions concerned which provides the immediate source of energy for conduction of the impulse

After an introduction in which he referred to the intimate biological relationships that exist between viruses and the cells they parasitize, Dr F K Sanders discussed that group of viruses, called 'neurotropic', which preferentially attacks the nervous system He pointed out that in some instances (for example, the poliomyelitis virus) such viruses even restrict their activity to certain groups of cells within the nervous system Experimental study of the poliomyelitis virus is rendered difficult by the fact that it is normally infective only in man, the chimpanzee and certain monkeys , hence investigation of the behaviour of the virus in the body is severely limited There is, however, a natural virus disease of mice, called spontaneous encephalomyelitis, which behaves in mice in a manner very similar to that of poliomyelitis in the monkey It was stressed that there is no reason for considering the two diseases to be closely related Nevertheless, study of the behaviour of the mouse virus might throw light on that of the virus of poliomyelitis

Dr Sanders then described experiments on the behaviour of the mouse encephalomyelitis virus following introduction of a 'severe' strain by direct inoculation into muscle The events following such inoculations depend upon the quantity of virus inoculated and on the age of the mice In adults, sufficient virus must be given to overcome a 'barrier' (probably situated at the nerve-muscle junction) to invasion by the virus , otherwise no infection of the central nervous system occurs In very young animals, however, the virus is able to multiply locally in the muscle to an extent sufficient to overcome the 'barrier' When the barrier has been overcome, the virus travels centrifugally along the actual fibres of the nerve supplying the muscle at a speed of about 0 5 mm an hour It does not multiply during this passage in the nerve fibres, but on reaching the cells of origin of the fibres multiplication commences This multiplication occurs without obvious disturbance of the normal functions of the infected nerve cells Only at the end of the cycle of multiplication are the cells destroyed with explosive suddenness Paralysis inevitably follows and a large amount of new virus is released When multiplication commences in a nerve cell, the virus is, as it were, 'dissembled' and seems completely to lose its identity and to be built into the cell structure Later, however, some fundamental disturbance of the life of the cell occurs and this is accompanied by the dissolution of its structure and the appearance of more virus

Dr Sanders indicated that the nature of this process is a problem for the future; but he stressed the fact that if murine spontaneous encephalomyelitis is considered from the point of view of the virus, the whole infectious process is virtually over before the symptoms considered to be characteristic of the disease appear There seems little doubt that this is also true of poliomyelitis

# HORMONES OF THE DIGESTIVE TRACT

POPULAR interest in the control of digestive functions has centred on Pavlov's demonstration of the reflexes, conditioned and unconditioned, which play such an important part in the regulation of salivary and gastric secretion The hormonal control of digestion has aroused less general interest, and, although much of the pioneer work in this field was done by British physiologists, it was only at the recent meeting of the British Association in Birmingham that a presidential address to Section I (Physiology) was for the first time devoted to the hormones of the digestive tract

The discovery of secretin, as Prof R J. Brocklehurst pointed out in his address, "was an eventful one, not only in connexion with the functions of the digestive system, but for Physiology as a whole It was the first clear demonstration of the liberation of a chemical substance from an organ into the blood stream and its specific action on another organ From this discovery, in fact, sprang much of the work on hormones of all kinds which has gone on during the first half of the present century and has become such an important branch of our science "

In the narrower field of the physiology of digestion, the discovery of secretin was the stimulus for two main types of investigation On one hand, by cross-circulation experiments and by transplanting pieces of the stomach, pancreas and gall-bladder to other regions of the body (the transplants being cut off from their original nerve and blood supply), it was shown that during digestion hormones are released into the blood stream which stimulate the stomach and pancreas to secrete and the gall-bladder to contract On the other hand, attempts were made to extract the active hormones from gastric and intestinal mucosa

Prof Brocklehurst surveyed the mass of work along these lines during the past fifty years which has established the existence of the hormones gastrin, which stimulates acid secretion by the stomach, secretin—the corresponding stimulant of the pancreas—and cholecystokinin, which brings about contraction of the gall-bladder There is evidence, too, that gastric activity, both secretory and motor, may be inhibited by the release of a hormone, enterogastrone, from the small intestine Gastrin and secretin have no stimulant action on the output of enzymes in gastric and pancreatic juice In addition to the well-established nervous control of digestive enzymes, these may also be influenced by hormones Pancreozymin, present in extracts of intestinal mucosa, increases the enzyme output of the pancreas without affecting the volume of the juice, and there is some evidence for an analogous hormone for pepsin secretion by the stomach

With the establishment by animal experiments of a number of hormones of the digestive tract, recent work has been concerned with the action of these substances in man, and with a more detailed study of the mode of their release during normal digestion In the discussion following Prof Brocklehurst's address, the actions and clinical uses of some of the gastro-intestinal hormones in man were considered by Prof A A Harper (King's College, Newcastle upon Tyne) Three materials—secretin, pancreozymin and cholecystokinin—have so far been prepared in a form sufficiently pure for intravenous injection in man, and it has been shown that their physiological effects are the same as those in animals To clinicians the interest of gastro-intestinal hormones lies in the possibility of their use in the diagnosis and treatment of disease Recently, attempts have been made to treat peptic ulcer by the parenteral administration of the inhibitory hormone enterogastrone, but the majority of reports so far have been unfavourable It has been claimed that the examination of the duodenal contents after secretin is of value in the diagnosis of malignant or chronic inflammatory lesions of the pancreas At present, attempts are being made to increase the value of the secretin test in man by following the secretin by an injection of pancreozymin and cholecystokinin A further improvement, as Prof A C Frazer pointed out, would be to measure the activity of digestive enzymes in conditions comparable with those occurring in the intestine

There has been increasing interest in recent years in the mechanism of the release of the digestive hormones For the release of gastrin there is evidence of the importance of a local nervous mechanism, with a receptor in the mucosa which can be paralysed by the local application of procaine, and an efferent cholinergic fibre acting upon the cell which produces gastrin Another line of attack on the problem is the study of absorption by the intestinal mucosa, since absorbed digestion products may carry some of the intestinal hormones into the circulation In a discussion of the activities of the intestinal mucosa, Dr R B Fisher stressed the very high metabolic rate of the mucosa, due in part to the work done in the active absorption of digestion products, and in part to the rapid multiplication of the cells of the mucosa, which in the rat may be completely replaced every thirty-six hours It seems likely that the mucosa builds up peptides from absorbed digestion products of protein, and it is known that the hormones are also peptide in nature Dr. Fisher pointed out that the presence of peptones in the gut leads to a build-up of proteins in the mucosa, and the application of injurious agents such as acid to the mucosa may lead to the breakdown of cytoplasmic protein As these agents are known to bring about a release of hormones from the intestine, Dr Fisher speculated upon the possibility that the hormones are normal products of the breakdown of mucosal cytoplasm, and that besides their specific hormonal activities they would "possess at the same time the generalized physiological activity of a specific building stone for the normal protein of the tissues"

This discussion undoubtedly served to stress the importance of the lining of the pyloric part of the stomach and the upper part of the small intestine as a prolific producer of hormones rivalling in number those of the anterior lobe of the pituitary gland

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# OBITUARIES

## Prof. E A Milne, M.B E, F R.S.

The sudden death of E A. Milne on the morning of September 21, in Dublin, while on his way to attend a colloquium convened in the rooms of the Royal Irish Academy by the Royal Astronomical Society, removes from our midst one of the great men of our time Mathematician, astrophysicist, cosmologist, relativist and natural philosopher, Milne was endowed with a range of abilities and a depth of insight which, combined with his incredible energy and indomitable will-power, enabled him to maintain an astonishing outpouring of research of the highest quality and originality over a period of some thirty years, despite physical tribulations and personal misfortunes of a kind which would have overwhelmed a lesser man

Edward Arthur Milne was born on February 14, 1896, the eldest son of Sydney Arthur Milne, of Hessle, East Yorkshire He was educated at Hymers College, Hull, and at Trinity College, Cambridge, where he was elected to a prize fellowship in 1919, after serving during the First World War with the Anti-Aircraft Experimental Munitions Inventions Department and receiving the M B E (In the Second World War he served at the Ordnance Board ) In 1920, H F Newall appointed Milne as assistant director of the Solar Physics Observatory in Cambridge Four years later Milne succeeded Sydney Chapman as Beyer professor of applied mathematics in the University of Manchester, a post which he held until 1928, when he was appointed first Rouse Ball professor of mathematics at Oxford and fellow of Wadham College

During his time at the Solar Physics Observatory and at Manchester, Milne's researches centred on problems of radiative equilibrium and the theory of stellar atmospheres In 1922 he was awarded a Smith's Prize for a new treatment of radiative equilibrium replacing the earlier investigations of Schwarzschild This work proved to be the starting point for many subsequent investigations by others A by-product of mathematical interest was 'Milne's integral equation', which attracted the attention of J E Littlewood, G H Hardy and E C Titchmarsh In 1923 Milne began a fruitful collaboration with R H Fowler on Saha's theory of high-temperature ionization By modifying Saha's technique, they deduced that the pressures of the levels in stellar atmospheres at which absorption lines were formed were of the order of $10^{-4}$ atmosphere, a value considerably lower than had previously been assumed Although much of this work was due to Fowler, the original key idea was Milne's The theory generalized by Milne in later papers

While still at Cambridge, Milne began his known investigations on the equilibrium calcium chromosphere under the balance of gravitational forces and radiation pressure. He discovered that for varying radiation from below the equilibrium was unstable, so that in certain circumstances atoms could ultimately be ejected from the sun with terminal speeds of the order of 1 600 km. per sec.

Milne's numerous memoirs on the opacity of stellar atmospheres culminated in his Bakerian Lecture of 1929. In the same year Milne took up his duties at Oxford, and during the following three years devoted his main energies to elaborating a theory of stellar structure based on a constructive mathematical criticism of the pioneer researches of Sir Arthur Eddington. In 1932 he delivered the Halley Lecture on "The White Dwarf Stars".

Meanwhile his interest had been aroused in the theory of the expanding universe, and in May 1932 he began that train of investigation which became the most original, the most controversial and the most far-reaching of the many theories associated with his name. He devised a new world-model which in its augmented form with a 'statistical component' appeared to be more fruitful than any of the homogeneous models hitherto produced by the 'orthodox' relativistic cosmologists. In particular, it provided an astonishingly simple explanation of Hubble's law correlating distance and velocity of recession, and also a possible gravitational explanation for the origin of cosmic rays.

Nevertheless, it is probable that that part of Milne's work in cosmology and relativity which will prove of the most lasting significance is the theory of time measurement by equivalent observers, on the basis of which new deductive systems of dynamics, gravitation and electrodynamics were developed in rapid succession. Associated with this work were two fundamentally novel ideas: the conception of different uniform scales of time operating in Nature, and the idea which first emerged from my analysis, arising out of Milne's generalization of my derivation of the Lorentz formulæ (itself suggested by remarks of Milne), that the fundamental group of equivalent frames is more restrictive than the six-fold infinite group of Newtonian and special relativity physics. The latter idea was explored further by Milne in his final contribution to the *Proceedings of the Royal Society* last year; but much still remains to be done.

It is impossible to convey here any detailed impression of Milne's many other contributions to stellar kinematics and dynamics, the kinematics and structure of spiral nebulæ, the theory of cepheid variation, etc.; it was characteristic of his courage that, although he knew his health was precarious, he made the journey to Dublin to read an exciting new paper on a relation, akin to Blackett's, connecting gravitation and magnetism, which had emerged from recent developments in kinematic relativity.

Apart from innumerable original memoirs, Milne published a long chapter on "The Thermodynamics of the Stars" in the "Handbuch der Astrophysik" in 1930 and three books: "Relativity, Gravitation and World-Structure" in 1935, "Kinematic Relativity" and "Vectorial Mechanics", both in 1948. He leaves two further books in manuscript: a life of Sir James Jeans, to be published by the Cambridge University Press, and a course of lectures which he was to have delivered at Birmingham this winter on the Edward Cadbury Foundation. He was also editor of the mathematical and physical sciences section of the series "Hutchinson's University Library".

Milne received many academic honours. He was elected a fellow of the Royal Society in 1926 at the age of thirty. He was awarded the Gold Medal of the Royal Astronomical Society in 1935, a Royal Medal of the Royal Society in 1941, and the Bruce Medal of the Astronomical Society of the Pacific in 1945. He was president of the London Mathematical Society during 1937–39, and president of the Royal Astronomical Society during 1943–45. He became an honorary member of the American Astronomical Society, a foreign honorary member of the American Academy of Arts and Sciences, both in 1947, and an honorary member of the Calcutta Mathematical Society in 1948. He was a D.Sc. (Oxon.) and an hon. D.Sc. (Amsterdam).

Milne was married twice. By his first wife, Margaret Scott (daughter of Hugh Fraser Campbell, of Dornoch, Sutherland), who died in 1938, he leaves two daughters and a son; by his second wife, Beatrice Brevoort (daughter of William Whetten Renwick, of New York), who died in 1945, he leaves a daughter.

Small in stature, Milne was outstanding in every other way. His penetrating and original intellect was sustained throughout many personal misfortunes by remarkable courage and unshakable religious conviction. Despite his brilliance of mind and widespread recognition, he retained a great humility and simplicity of character. To his research students, particularly to those of us who knew him in his prime, he was an unfailing source of inspiration. He was always the kindest and most conscientious of supervisors and collaborators. We mourn the passing of a leader among men of science and a pioneer among philosophers of Nature.

G. J. Whitrow

## Dr. D. H. Bangham

Physical chemistry, and perhaps more specifically fuel technology, have suffered a grievous loss by the death on July 29, at the early age of fifty-five, of Dr. Donald Hugh Bangham, director of Research Laboratories, British Coal Utilisation Research Association. His health had not been good for some little time; but his end came rather suddenly and as a sad blow to his immediate colleagues.

The quality of his mind was evident at an early age; in 1912 he won a scholarship in natural science to Jesus College, Oxford. Two years later he was commissioned in the King's (Liverpool) Regiment, attaining the rank of captain and gaining the Military Cross for leading an attack on the Hindenburg Line defences. Shortly after returning to academic life, he graduated with first-class honours and was appointed (1919) lecturer in physical and inorganic chemistry in the University of Manchester, where he published a number of papers concerned with rate-processes at the gas-solid interface; he revealed two characteristics: careful and elegant technique and a great power of generalization.

In 1926 Bangham accepted the chair of physical and inorganic chemistry in the newly founded Faculty of Science in the University of Cairo, where he was faced with the task of planning and equipping the laboratories, as well as preparing curricula. He served as dean of the Faculty during 1927–36, and on returning to England in 1937 he was awarded the Order of the Nile with the rank of commander.

Bangham joined the staff of the British Coal Utilization Research Association in 1938, almost at its inception, and played a prominent part, in recruiting scientific personnel and initiating their work During the following twelve years he displayed outstanding leadership in researches concerned with the physical structure of coal and with the mechanism of its combustion Previous approaches had been made by the analytical chemist and the geologist, Bangham followed the line that bright coal was a solid colloid, or an assembly of small particles too small to be visible under the microscope and imparting to the lump a porous structure This conception has led to a model adequately accounting for the variation with rank of the properties of different coals It has also been of great assistance in elucidating the complicated phenomena associated with solid fuels undergoing combustion, for example, 'reactivity'.

Two days before he died, Bangham was able to peruse a new work, "Progress in Coal Science", which he had edited, this work is a fitting memorial to his great ability and activity in editing for publication the considerable output of the British Coal Utilization Research Association

Bangham was a great gentleman and a loyal colleague, whole-heartedly devoted to science and its industrial applications, and he gave much in exchange for little Towards the end he fought against ill-health with a gallantry that evoked the esteem of all who knew him intimately, and he will be sorely missed He leaves a widow, two sons and a daughter D T A TOWNEND

## Mr. William Birtwhistle

MANY visitors to the Cavendish Laboratory will have met Willie Birtwhistle, whose death occurred on September 25 For the past twenty years he had cared for the high-voltage accelerator of the Laboratory He was trained in electrical engineering, and we were fortunate in being able to bring him to Cambridge when we started to build our proton accelerator in 1930 We had to instal a high-voltage transformer and exciting equipment, to build a voltage multiplying rectifier and accelerating tubes, and to apply the new technique of fast oil-diffusion pumps to our work In all of this, Birtwhistle played a major part A good deal of time had to be spent on finding leaks in the numerous seals which were then made by the use of low vapour-pressure 'Plasticine' developed for the work, and we will always remember the patience and care with which Birtwhistle thumbed the joints until the diffusion-pump spark discharge turned from pink to green and then finally to black

In all the experimental work during 1932–37 with Dee, Gilbert, Lewis, Walton and myself, Birtwhistle took a full part He always used to know what an experiment was about without being told, and he had always a very good sense of what was wrong when any trouble developed.

When the new high-voltage laboratory of the Austin Wing was built, he moved to the new laboratory and built and installed to Dee's design the one-million volt accelerating tube which worked with the Philips cascade generator During the difficult years of the War the laboratory was kept going steadily for the work of the atomic energy project, and the return to academic work in 1945 was greatly helped by the loving care with which it had been tended

Birtwhistle was a typical north countryman with a quiet humour and Yorkshire accent which was a pleasure to listen to His patient ways and sound experimental sense inspired confidence in research students and helped many of them over their difficulties He was a keen collector of stamps, and many research students who went overseas added to his collection

Experimental physics owes much to its research assistants, and Willie Birtwhistle will take his place in their honoured roll J D COCKCROFT

WE regret to announce the following deaths

Sir Sidney Harmer, K B E, F R S, director of the British Museum (Natural History) during 1919–27, on October 22, aged eighty-eight

Prof S Sugden, F R S, professor of chemistry at University College, University of London, on October 20, aged fifty-eight

Prof Emil Votoček, emeritus professor in the Czech Institute of Technology, Prague, known for his work in organic chemistry, on October 11, aged seventy-eight

# NEWS and VIEWS

### Cedergren Medal for 1949: Prof. R Rudenberg

PROF REINHOLD RUDENBERG, Gordon McKay professor of electrical engineering in Harvard University, has been awarded the gold Cedergren Medal and Scroll for 1949 for highly meritorious work in the field of electrical engineering The Medal was founded by the Stockholm General Telephone Co in memory of Henrik Tore Cedergren, director of telephony, and is awarded every five years for work in the art and science of electricity by the Royal governors for the universities of technology in Sweden Prof Rudenberg, who is the eighth recipient of the Medal, was born in Hannover in 1883 and studied engineering at the Hannover Institute of Technology He was an honorary professor at the Institute of Technology in Charlottenburg while he worked as chief electrical engineer of Siemens-Schuckertwerke in Berlin during 1923–36 He went to Harvard in 1939 In 1912 Prof Rudenberg was awarded the Montefiore Prize of the University of Liège for research on commutator machinery and in 1946 received an honour award medallion from the Stevens Institute of Technology for his work in connexion with the invention of the electron microscope

### Names of Chemical Elements

THE names of chemical elements have been under consideration at the fifteenth congress of the International Union of Pure and Applied Chemistry which took place in September 1949 at Amsterdam The report of the Congress is now available (Siège de l'Union, 28 Rue Saint-Dominique, Paris, 7e) The Commission on Inorganic Chemical Nomenclature made the following recommendations, which were adopted by the Union, for the newly discovered elements Element 43 should be called 'Technet [illegible]' (Tc), 61 'Promethium' (Pm), 85 'Astatine' (A 'Francium' (Fr), 93 'Neptunium' (Np), 94 'Plu

(Pu), 95 'Americium' (Am), 96 Curium' (Cm). In all these cases the guiding principle was to accept the names proposed by the real discoverers and to delete names like 'Masurium' or 'Illinium' which were adopted previously on account of spurious claims to the discovery of elements 43 and 61 (see *Nature*, **159**, 8, 1947). An attempt was also made to remove some inconsistencies in the names of the older elements. The application of the same principle of historical correctness is here often difficult for lack of clear evidence, and also because it is open to debate how far it is advisable to change long-established names even if justice seems to demand it. A case in question is the name of element 71 (see *Ergeb. Exak. Naturwiss.*, **2**, 168, 1923). In 1909 the International Atomic Weight Commission—consisting of Clarke, Ostwald, Thorpe and Urbain—wrongly accepted Urbain's name 'lutecium' instead of Auer von Welsbach's 'cassiopeium', but since, in consequence of this decision, the former name has received wider recognition, one cannot but approve of its sanctioning by the Amsterdam Congress. Such practical considerations must weigh the heavier the more firmly established a name is. Other names proposed are 4 'Beryllium' (Be), 41 'Niobium' (Nb), 71 'Lutetium' (Lu), 72 'Hafnium' (Hf), 74 'Wolfram' (W), 91 'Protactinium' (Pa). In view of the widespread use of tungsten not only in the laboratory but also in industry, practical considerations alone suggest that changing the name to 'wolfram' would be undesirable and cause confusion.

## Northern Rhodesia Society

THE Northern Rhodesia Society has been formed with the object of promoting the study of various aspects, past and present, of Northern Rhodesia and its peoples. A major activity of the Society will be to publish the *Northern Rhodesia Journal*, which will appear twice a year and which, subsidized by the Government, will cost 5*s*. a copy. Such topics as Northern Rhodesian history, natural history, memoirs of 'old-timers', sociology and current developments will be covered, so as to supply something of interest both to the expert and the ordinary citizen. The *Journal* will be well illustrated, with six to eight articles plus smaller features, and will be a permanent record of all that matters in the Territory. Ordinary members of the Society (subscription 15*s*. a year) will receive the *Journal* free and will, in addition, have the privilege of borrowing books from the extensive Rhodes–Livingstone Museum Library, and of attending meetings and discussions of the Society which will be held in the main towns. Associate membership (5*s*. a year) covers use of the Library for reference only and attendance at meetings. Further particulars can be obtained from the Secretary, Northern Rhodesia Society, Rhodes–Livingstone Museum, Livingstone, Northern Rhodesia.

## Care of Archæological Sites

AN article in the *South African Archæological Bulletin* (5, No. 18, June 1950) makes sad reading. At Saulspoort, in the Bethlehem district, rock-shelter paintings occur and an important 'gisement' was identified. It is always of great interest to attempt to correlate the parietal art with datable deposits at the same site. The work of excavation was begun, but during a period of the workers' absence intruders arrived who just 'hogged' the site and left a yawning pit where the section should have been. The problem of controls is a difficult one. Too rigid rules defeat their own object. It is, in a subtle way, the general interest in archæology among all classes that makes the subject live and enables the few professionals to continue the study. Without this general interest the subject would in practice wither. A certain freedom to explore must therefore be given to the amateur; but, of course, stories such as this one are major tragedies. Perhaps the problem could best be tackled through the schools. If the young folk were taught to realize that Stone Age sites are not innumerable and should be respected, that 'hogging' sites is a crime and that excavations should only be attempted either under a competent excavator or after having already had experience in digging, then such grievous happenings as occurred at Saulspoort would no longer occur.

## Nomenclature of Viruses

AT the plenary session on August 24 of the Fifth International Congress of Microbiology at Rio de Janeiro (see p. 730), it was recommended that consideration of the starting date for scientific nomenclature of viruses be deferred to the next Congress. Further, the Judicial Commission of the Congress was of opinion that until studies on viruses now in progress have advanced further, the use of any comprehensive system of scientific nomenclature for them is unwise. The co-operation of all virologists is requested in assisting the sub-committee now studying the nomenclature and classification of viruses. The object of these resolutions is to encourage study of the taxonomy and nomenclature of viruses, but to discourage use at the present time of what are considered premature attempts to create comprehensive systems of classification and nomenclature. The chairman of the Virus Sub-Committee of the International Nomenclature Committee is Dr. C. H. Andrewes, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7.

## New Type of Mechanical Gear

A MECHANICAL gear which may be useful in scientific instrument design has been invented by Mr. J. J. Gerritsen, chief engineer of Tiltman Langley Laboratories, Ltd., Redhill, Surrey, which is now developing units based on this invention. The Gerritsen gear consists of a ball race in which the cage and rollers are used as the spider and planet wheels of an epicyclic gear. The races are conical, and by moving them axially the gear ratio may be varied; the centrifugal force on the balls can be used for adjusting the axial position automatically in such a way that the output shaft rotates at a constant speed, while there can be considerable variation of the input shaft speed. It is claimed that the operation of this governing mechanism is extremely rapid, so that the output shaft is little affected even by sudden changes of speed of the input shaft. All the parts of the gear can be easily made. The limiting factor in its performance is presumably the stress at the ball contacts, these points being required to carry tangential load in addition to the normal forces which are found in ball races.

## Rheola Forest, Wales

WALES was a beacon to holiday-makers long before the advent of the motor-car. It had, and has, in parts one serious drawback, the dumps of coal-pit refuse, and, less ugly perhaps, the small rough pyramids of refuse from the slate quarrying. The Rheola Forest in the Vale of Neath is a typical example of the type of afforestation work which is now taking place in the former type of industry. The name Rheola Forest comes from the estate of Rheola, near Resolven, lands from that estate forming the nucleus of the large area of 13,000 acres which now forms the Forest. Planting was commenced there by the Forestry Commission in 1922, and the oldest of the plantations are yielding substantial quantities of pit-props for the coal-fields in the Vale. "The green mantle of foliage," as the writer of the pamphlet, "Britain's Forests—Rheola" (Forestry Commission Pp 18 (London H M Stationery Office, 1950 6*d* net), picturesquely puts it, "spreading across both sides of this industrial valley provides a welcome contrast to the bare hillsides with dumps of coal-pit refuse." A start has also been made with planting up the old abandoned pit dumps and thus removing a real eyesore to any countryside. A successful planting of this nature with Scots pine on the old Trafalgar coal-pit dump in the Forest of Dean has changed that blot into a round green hill.

## Mixed Commission on Radiobiology

THE Mixed Commission on Radiobiology of the International Council of Scientific Unions held its first meeting on July 16 in the Library of the Pasteur Pavilion of the Institut de Radium, Paris. Those present were Dr L H Gray, Dr G Failla, Prof G Hevesy, Mme I Joliot-Curie, Prof A Lacassagne, Dr L D Marinelli, Dr Melander, Dr R Naidu and Dr P Bonét-Maury. The International Council of Scientific Unions was represented by Dr Fraser, and the United Nations Educational, Scientific and Cultural Organisation, through the financial aid of which the meeting was possible, by Dr Wang. Prof Hevesy was elected president of the Commission, and Dr Bonét-Maury secretary. The work of the Commission is concerned principally with the organisation of radiology, from the point of view of both research and of teaching, and the main topics discussed were: the project of an international institute of radiology; the publication of radiobiological work and a bibliography of such work; the definition and measurement of sensitivity to radiation; and the possibility of the exchange of standard biological material. It was decided to create a sub-commission which will study the first and third of the above-mentioned topics.

## *Australian Journal of Marine and Freshwater Research*

THE Commonwealth Scientific and Industrial Research Organization has decided to launch a new scientific periodical, the *Australian Journal of Marine and Freshwater Research* (1, No 1, April; pp 154; from the Secretary, C S I R O, 314 Albert Street, East Melbourne, C 2, 1950; 7*s* 6*d*), which will be a medium for the publication of research papers on the results of original investigations on sea, estuarine and freshwater fisheries and cognate subjects. Dr N S Noble, of the Organization's staff, has been appointed editor. He will have the help of an editorial advisory committee in scrutinizing manuscripts submitted for publication, and this committee has as its members Mr G Humphrey (Department of Biochemistry, University of Sydney), Prof P D F Murray (Department of Zoology, University of Sydney) and Dr H Thompson (chief, C S I R O Division of Fisheries). The *Journal* will not be issued at set periods, but as the accumulation of suitable material dictates. It is at present anticipated that two issues will be published in each year. The first number has just appeared and contains papers on the Australian anchovy, underwater fouling, the barracuta fishery in Australian waters, bacteriology of shark spoilage and the setting of Sydney rock oysters.

## *Journal of the Royal Technical College, Glasgow*

PUBLICATION of the *Journal of the Royal Technical College, Glasgow*, which was suspended during the War, has now been resumed, and the first post-war number to appear (5, Part 1, January 1950) contains twenty-six research papers contributed by members of the staff and senior students of the College. A list of other publications by members of the College is included; but only the titles of the periodicals in which the articles appear, and not the full references, are given. In one of the papers, T S Wylie describes experiments which show that cavitation can occur in a liquid irradiated with sound of frequency 3,780 c s. An oscillator consisting of a nickel tube made to vibrate by magnetostriction at audio frequencies was used, and the form of the cavitation produced in water at the frequency of 3,780 c s was examined. Evidence was obtained that the rate of erosion on a metal surface in contact with a field of cavitation varies, at constant temperature, with some power of the time greater than unity. Several of the papers in the *Journal* deal with problems of a chemical nature; and, on the metallurgical side, blast-furnace reactions, the reactions of sulphur in steel-making, the sintering of iron ores, thermal changes in fireclay and kaolinite, and the surface tension of molten silicates form the subjects of individual articles. The publication concludes with a number of papers dealing with problems in structural engineering and shipbuilding.

## Ministry of Agriculture and Fisheries Postgraduate Scholarship Awards

THE Ministry of Agriculture and Fisheries has awarded the following postgraduate research and training scholarships, which are tenable for periods up to three years in the first instance at the university or institute shown: *Agricultural economics*, G H. Brayshaw, G B Clarke and Miss C O'Loughlin (Cambridge), J T Creighton, T C Haddow and Miss C Scott (Oxford), and D T Edwards (Reading); *Agricultural engineering*, P Hebblethwaite (Michigan State College), E W Hughes (Reading), and R E James-Robertson, J N Merridew and G B Shipway (King's College, Newcastle); *Husbandry*, H K Baker, R W E Ball and D R Hodgson (Cambridge), C W. Bramley (Leeds), J Alston, J Cook, A J Cooper, T L Crocker, C G Guttridge, L A Mantle and J J North (Reading), Miss J C Whitaker (Wye College, London), and C E Wright (Queen's University, Belfast); *Agricultural statistics*, Miss E M Davis and J K R Wood (Rothamsted Experimental Station), J A Evans (Oxford), and A F Purser (Edinburgh).

## Foreign Scholarships for British Students

A NUMBER of foreign governments and universities are offering scholarships to British students. In most cases the awards are for 4–12 months of postgraduate study at a university, but the Italian Government also offers scholarships to authors, artists, musicians and others for study or travel in Italy. Scholarships for 1950–51 have recently bee announced, the countries and the number of awards are as follows Austria (3), Belgium (8), Denmark (3), Finland (1), France (4), Germany (4), Italy (3), The Netherlands (6), Norway (4), Persia (1), Spain (1), Sweden (4) and Switzerland (1) Awards by the Government of Brazil will be announced shortly These scholarships by foreign countries correspond to those awarded by the British Council to foreign graduates for studying at universities in the United Kingdom Further details about these schemes can be obtained from the British Council, 65 Davies Street, London, W 1

## Sectional Meeting in New Delhi of the World Power Conference

THE second post-war sectional meeting of the World Power Conference will be held in New Delhi during January 10–15, 1951 At the same time, the World Power Conference International Commission on Large Dams will hold its fourth congress, and the International Commission on Irrigation and Canals its first plenary session During January–February an Indian international engineering exhibition will be open in New Delhi The theme of the sectional meeting is the "Utilization of Power in its Various Aspects", and this will be considered under two headings utilization of electricity in agriculture, and the co-ordination of the development of industries and the development of power resources A set of three study tours (and an alternative set) which between them cover most of the territory of India has been arranged, and on the completion of these tours the closing session of the conference and congress will be in Mysore on February 1 Details of these events are contained in Bulletin No 2, issued by the Indian National Committee of the World Power Conference This Bulletin can be obtained from the Secretary, Central Board of Irrigation, Curzon Road Barracks, New Delhi, or from the British National Committee, World Power Conference, 201 Grand Buildings, Trafalgar Square, London, W C 2

## Royal Society of Edinburgh: Officers for 1950–51

AT the annual statutory meeting of the Royal Society of Edinburgh, held on October 23, 1950, the following officers and members of council were elected *President*, Prof James Kendall, *Vice-Presidents*, Prof A C Aitken, Prof E P Cathcart, Sir Alexander Gray, Prof Arthur Holmes, Prof W O Kermack and Prof E T Copson, *General Secretary*, Dr. J E Richey, *Secretaries to Ordinary Meetings*, Prof J Norman Davidson and Dr John E MacKenzie, *Treasurer*, Mr A W Young, *Curator of Library and Museum*, Dr Douglas Guthrie, *Councillors*, Mr E G Dymond, Prof R W Wheldon, Prof T Neville George, Prof J W Heslop Harrison, Dr C E Lucas, Prof M G Say, Prof W M Smart, Prof J F Allen, Prof A Murray Drennan, Dr E Wyllie Fenton, Mr J M Ross and Prof C M. Yonge

## The Night Sky in November

NEW moon occurs on Nov 9d 23h 25m, U T, and full moon on Nov 24d 15h 14m The following conjunctions with the moon take place Nov 6d 19h, Saturn 2° N, Nov 13d 04h, Mars 4° N, Nov 16d 23h, Jupiter 1° N Mercury, in superior conjunction on November 1, is too close to the sun for favourable observation during the month Venus, in superior conjunction on November 13, is unfavourably placed for observation during most of the month Mars is an evening star and sets more than two hours after the sun during November, its declination is more than 24° S and, as it lies rather low even at meridian passage in the British Isles, it is not well placed for observation Jupiter, in the constellation of Aquarius, sets at 0h 10m, 23h 20m and 22h 30m on November 1, 15 and 30, respectively, and is well placed for observation Saturn, in the constellation of Virgo, is a morning star, rising at 3h, 2h 15m and 1h 25m at the beginning, middle and end of the month, respectively Occultations of stars brighter than magnitude 6 are as follows Nov 6d 4h 47 6m, 89 Leon (*R*), Nov 20d 20h 46 0m, ε Pisc (*D*), Nov 26d 18h 23 3m, 136 Taur (*D*), Nov 26d 19h 05 2m, 136 Taur (*R*), Nov 30d 0h 39 0m, γ Canc (*R*) *R* and *D* refer to reappearance and disappearance, respectively, and the latitude of Greenwich is assumed

## Announcements

SIR LEWIS FERMOR has been elected president for the session 1951–52 of the Institution of Mining and Metallurgy Sir Lewis served with the Geological Survey of India from 1902 until his retirement as director in 1935 He has since been engaged in consulting work in India, Malaya and Africa

THE Council of the Royal Society of Edinburgh has awarded the David Anderson-Berry Prize for 1950, posthumously, to Dr D E Lea, for his book "The Actions of Radiations on Living Cells"

THE Melchett Medal for 1950 of the Institute of Fuel has been awarded to Prof R J Sarjant, professor of fuel technology in the University of Sheffield The Medal was established and endowed by the founder-president of the Institute, the late Lord Melchett of Landford, and is awarded from time to time for outstanding work in research, administration, construction or any other professional activity involving the scientific preparation or use of fuel. There have to date been six overseas recipients, and Prof Sarjant is the fourteenth British holder of the award.

MR. G M. MICHIE has joined the Research and Development Division of the British Steel Founders' Association in a senior executive capacity Mr Michie, who for the past two years has been senior research metallurgist in charge of the research laboratories at Penistone of Messrs. David Brown and Sons (Huddersfield), Ltd, is known for his work on the development and application of non-destructive testing of steel castings

THE Institution of Naval Architects has made the following awards Froude Research Scholarship in Naval Architecture (1950), of £500 a year for two years, to R L Townsin, of King's College, Newcastle upon Tyne, Sir William White Postgraduate Scholarship in Naval Architecture (1948), of £150 a year, to D I Moor, of Messrs William Denny and Bros, Dumbarton, for one further year, Parsons Scholarship in Marine Engineering (1950), of £175 a year, to G M Jordan, of Messrs Alfred Holt and Co, Liverpool, for three years at the University of Liverpool, Yarrow Scholarship in Marine Engineering (1950), of £175 a year, to A W Bolwell, of Messrs Yarrow and Co, Scotstoun, Glasgow, for four years at the University of Glasgow.

# DYNAMICS OF INDUSTRIAL LOCATION

INTEREST in problems of industrial location was greatly stimulated in Great Britain in the years between the two World Wars by the declining prosperity of many long-established industries and the severe incidence of unemployment in those regions where these industries were located At the same time, the relative prosperity of southern England and the Midlands where the newer industries were rapidly expanding led many persons to question the desirability of allowing industrialists unrestricted freedom to set up their factories where they willed without reference to the social costs involved in heavy localized unemployment and the loss of capital assets represented by local government services, buildings, roads, railways and other capital assets which were likely to become redundant, or only partially utilized, because of the transference of people from these older industrial areas to areas where new buildings, transport facilities and public utility services would have to be provided It was suggested that the jobs should be brought to the workers rather than that workers should be brought to new jobs in new industrial areas On the other hand, it was pointed out that, in the long run, industrial efficiency and the power to compete in export markets would be reduced if artificial regulation of industrial location resulted in industry being forced to settle in areas where the net economic advantages were less than those enjoyed when full freedom of choice was permitted Location, it was stressed, is a dynamic and not a static problem, and that historically there have been many shifts in the industrial centres of gravity

Obviously, before any reconciliation can be effected between these opposing points of view, the necessary prerequisite is a knowledge of the facts What are the factors which determine the choice of location for a factory or other industrial plant, and how can we measure and compare the net advantages, both economic and social, of different localities ? The need for greater knowledge was stressed by Dr H S Phillips in a paper entitled "Some Factors determining the Movement of Industry—1934–1950", read before Section F (Economics) at the recent meeting in Birmingham of the British Association for the Advancement of Science Dr Phillips emphasized that anything which improves knowledge of location matters will help to increase both the social benefit and private profit to be derived from improved location decisions, and will provide a basis on which the difference between private and community location interests can be bridged Had location knowledge and ideas been as widely appreciated and disseminated in the inter-war years, or the relevant statistics been as readily available as they are now coming to be, many industries which settled in areas which ultimately became overcrowded would have been attracted to the Development Areas twenty years ago with equal or greater success and with a vast interim saving to the community in terms of unemployment and strategic liability

In his survey of the factors determining movements in industry during 1934–50, Dr Phillips divides the fifteen years into four main periods The first (1934–38) was one in which, despite the initial activities of the Special Areas Commissioners, there was complete freedom for industrialists to establish their factories in any part of the country Many of the factories built in this period were concerned with the production of consumer goods such as electrical equipment, radios or plastic articles, and they were largely attracted to cities such as London and Birmingham, where large markets were on their doorsteps , this was a continuation of a trend which had manifested itself since 1920 There was also a peripheral spread of industry in London to districts where labour was more readily available than in the centre and where costs were lower This, however, was a trend which was noticeable even before 1914, for example, in printing, and which has continued up to the present day, for example, in clothing The second period (1939–45) was one in which location was affected by concentration of non-essential firms, by the 'Blitz' and by the strategic building policy which had started before the War with the shadow-factory programme Many large government factories were built in areas which would probably never otherwise have obtained such buildings

The third period lasted from 1945 to about the middle of 1948 It was radically different from the other periods in that strong conscious efforts were made, following the passing into law of the Distribution of Industry Act, 1945, to prevent further industrial development in the South and the Midlands The policy was largely operated through a procedure which made the granting of building licences largely dependent on prior approval of the scheme on location grounds During this period, difficulties of labour supply and site shortages in the South and Midlands helped to drive considerable numbers of firms to the North and to Wales New firms were encouraged to go to the Development Areas by attractions such as government factories, raw material allocations, assistance in the purchase of sites, provision of houses for key workers and the laying-on of gas, water and electricity

In the fourth period (mid-1948 onwards), Dr Phillips considers that the location factors operating may approach more closely to the pre-war pattern, unless they are consciously prevented from doing so The availability of labour in the years to come will, he considers, give the Development Areas a very real attractive power Firms, however, are now more conscious of costs than in the early post-war years, and they are reluctant to face the considerable capital expense involved in transferring production to a new locality They have also become more concerned about the unknown cost elements of a new location Dr Phillips considers that there is evidence in recent experience for assuming that production costs at different locations in such a relatively small country as Great Britain differ much less than is generally assumed between comparable production units. There is probably much to be said for this view in connexion with light industries, especially as a result of the development of road transport and the telephone service during the past twenty years or so On the other hand, the increase in transport costs which is now taking place may have to some extent a restrictive effect on choice of location

During the post-war period the availability of labour has been the vital location factor favouring the older industrial areas Pre-war unemployment was substantial even in relatively prosperous areas, and workers could be found without the need of offering enhanced wages. This factor has been strengthened by the fact that whereas sites for both housing and industry have been scarce and subject to strict control on planning grounds in the South and Midlands, there has been a special drive for sites in central Scotland, Wales, Tyneside and Merseyside as part of a positive plan to encourage the settlement of industry

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# THEORY OF SORPTION COLUMNS

## The $\Psi$ Conditions · Two Types of Non-Equilibrium Fronts

A PROCESS in a sorption column can be described completely by giving for each molecular species $A_i$ its concentrations $c_i$ and $q_i$ as functions of $x$ (the amount of sorbent in cm or gm between the layer $x$ and the inlet end) and $V$ (the volume of solution that has passed the layer $x$) For an *equilibrium* process, $c_i$ and $q_i$ are functions of a single variable,

$$\Psi = V/x, \tag{1}$$

when the boundary conditions contain only $\Psi$ (uniform composition of the initial sorbent at $\Psi = 0$ ($V = 0$), and uniform composition of the entering solution at $\Psi = \infty$ ($x = 0$)) and not $V$ or $x$ separately. For most practically important cases, this condition is valid or can be made valid by a suitable change in the co-ordinates

An approach essentially equivalent to this '$\Psi$ condition' has already been used by Offord and Weiss[1] for some special cases A great simplification can be gained by a consistent use of it When the $\Psi$ condition applies, the conservation law requires that, for all continuous regions,

$$\begin{aligned} &\text{either } c_i = \text{const} \\ &\text{or } dq_i/dc_i = \Psi \text{ (diffuse front).} \end{aligned} \tag{2}$$

Finally, for the discontinuities (sharp fronts),

$$\Delta q_i/\Delta c_i = \Psi_s \tag{3}$$

In a paper to be published in the *Arkiv for Kemi*, these equations will be applied to a number of important cases, such as frontal analysis and displacement analysis Especially in connexion with $V$—$x$ diagrams, this approach will be shown to give a uniform, quick and simple way of treating and understanding the processes

For ion exchangers it is advantageous to use instead the fractions of the various ions in solution and sorbent

$$\alpha_i = \frac{q_i}{s_0},\ \beta_i = \frac{c_i}{a_0}, \text{ where } s_0 = \Sigma q_i,\ a_0 = \Sigma c_i, \tag{4}$$

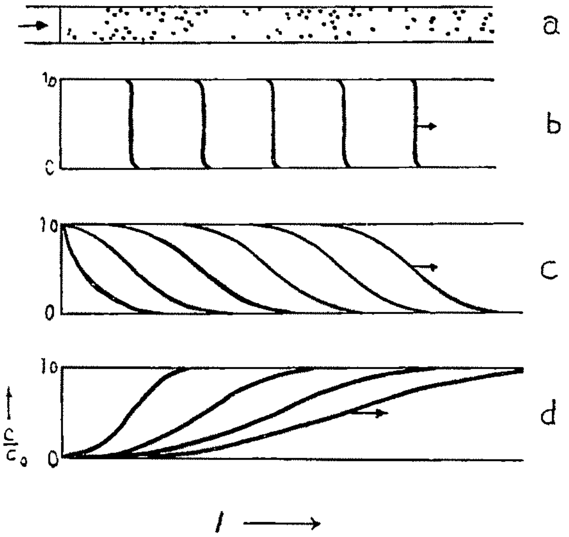
and to replace $\Psi$ by the proportional quantity

$$\psi = a_0 V/s_0 x \tag{5}$$

We then find

$$\begin{aligned} d\beta_i/d\alpha_i &= \psi \text{ for continuous fronts,} \\ \Delta\beta_i/\Delta\alpha_i &= \psi_s \text{ for sharp fronts} \end{aligned} \tag{6}$$

*Non-equilibrium* processes in sorption columns are best treated by first considering the corresponding equilibrium process With increasing $V$ and $x$, the curves $c_i$ ($\Psi$) and $q_i$ ($\Psi$) will approach indefinitely to the equilibrium curves



(*a*) Sorbent layer, (*b*) sharp front of constant form (advancing), (*c*) broader front of constant form (advancing), (*d*) broadening front (retiring) In *b–d*, the abscissa is the length of the column, the ordinate is $c/c_0$, where $c$ is the concentration of $A$ in the solution The curves refer to different times (or values of $V$)

Where a sharp front would have been formed at equilibrium, a *final form front* is obtained for non-equilibrium The front eventually moves through the column with a constant form and a constant velocity Then $q_i$ and $c_i$ are functions of the single variable

$$z = x - V\Psi_s^{-1}, \tag{7}$$

which is the distance from the position the sharp front would have had at equilibrium Moreover, for each substance,

$$\frac{q_i - q'_i}{c_i - c'_i} = \frac{q''_i - q'_i}{c''_i - c'_i} = \Psi_s, \tag{8}$$

which means that the point $q_i$, $c_i$ is on the straight line connecting the points $q_i''$, $c_i''$ and $q_i'$, $c_i'$, valid far behind and far ahead of the front

So far as I know, the first attempts at a general treatment of final form fronts were made by Johansson, Persson and Svensson[2], and Sillén[3]

If the sorption process follows Langmuir kinetics, the following formulæ can be derived for the sorption of one sorbate on an initially empty sorbent

$$\frac{q}{q''} = \frac{c}{c''} = \frac{1}{1+Z},\ Z = \exp kq''z, \tag{9}$$

and for the sorption of an ion in an ion exchanger, which is initially saturated with a less sorbable ion,

$$\beta = \alpha = \frac{1}{1+Z},\ Z = \exp(k - k_1)s_0 z. \tag{10}$$

In these equations, $k$ and $k_1$ are the kinetic constants.

If a Tiselius displacement analysis is carried out under non-equilibrium conditions, the various substances will finally arrange themselves in front of the displacing substance $A_N$ (in the bulk of which $q''_N$ and $c''_N$ are valid) in the order of decreasing sorbability, just as in the equilibrium case The fronts will no longer be sharp, but each substance will form a diffuse 'head' and a diffuse 'tail', both of constant form However, for each substance, the following expression still holds

$$\frac{q_i}{c_i} = \Psi_s = \frac{q''_N}{c''_N}. \tag{11}$$

This is Tiselius's equation[4], which is thus valid for the non-equilibrium displacement

The other type of front is the *broadening front*, the best theoretical approach to its form is probably by using the condition that $c_i(\Psi)$ and $q_i(\Psi)$ approach the curves for equilibrium for increasing $V$ and $x$ Sometimes 'false isotherms' may prove useful (see the following communication)

Several treatments in the literature of non-equilibrium processes in sorption columns are based on assumptions, such as formal analogy to heat transfer, which would lead to a linear isotherm It is true that a linear isotherm may sometimes be a useful approximation in partition chromatography However, so far as ordinary sorption processes are concerned, the focusing of attention on linear isotherms seems to be unfortunate A linear isotherm is a singular case, it would give fronts showing the characteristics of neither of the two immensely more important groups of fronts, the final form fronts, and the broadening fronts With a linear isotherm, no final form front is obtained, the fronts will broaden, but to a less extent than normal broadening fronts, so that the curves $c_i(\Psi)$ and $q_i(\Psi)$ finally approximate to vertical lines and not to continuous curves The results calculated for a linear isotherm will thus disagree with what is observed in almost all types of experimental sorption or desorption runs

LARS GUNNAR SILLÉN

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[1] Offord, A C, and Weiss, J, Faraday discussion, Reading, Sept 1949 (in the press)

[2] Johansson, C H, Persson, G, and Svensson, B (1948) IVA, No 200 The work was concluded in 1942, the manuscript prepared in 1945

[3] Sillén, L G, *Arkiv Kemi*, 22*A*, No 15 (1946)

[4] Tiselius, A, *Arkiv Kemi*, 16*A*, No 18 (1943)

[5] For example, Boyd, G E, Myers, L S, and Adamson, A W, *J Amer Chem Soc*, 69, 2849 (1947)

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## Kinetics and Equilibria of Ion Exchange

ALTHOUGH a great amount of work has been performed on the kinetics and equilibria of ion exchange, they have not hitherto been well understood, or successful empirical formulæ worked out

A few years ago, two of us began studying the exchange of silver and hydrogen ions on different ion exchangers[1] The chief reason for this choice was that even very low concentrations of silver ion can be measured accurately and quickly by means of silver electrodes

Silver ions are more strongly adsorbed than hydrogen ions by the ion exchangers studied by us. If an ion exchanger is originally saturated with hydrogen ion (thus in the form H$R$), and silver ions are passed through, it can be expected[2] that the 'silver front' will quickly approach a final shape, and then move on with *constant form* and constant velocity through the ion exchanger column This was indeed found to be the case[1]. This result, however, is at variance with formulæ analogous to those for heat transfer which would correspond to a linear sorption isotherm, and which demand that the front will in any event broaden indefinitely with increasing column-length and time[3]

Our first working hypothesis was that the process in the ion exchanger can be treated as a bimolecular reaction

$$\begin{array}{ccccccc} \mathrm{Ag}^+ & + & \mathrm{H}R & \underset{k_1}{\overset{k}{\rightleftharpoons}} & \mathrm{H}^+ & + & \mathrm{Ag}R \\ \alpha a_0 & & (1-\beta)s_0 & & (1-\alpha)a_0 & & \beta s_0 \end{array} \qquad (1)$$

With this assumption we were able to derive a rather simple formula ( = (10) in preceding paper) ·

$$\alpha = \beta\,, \ \log\left(\frac{1-\alpha}{\alpha}\right) = k'(t_0 - t)\,, \qquad (2)$$

$$k' = (k-k_1)\,a_0 \log e\,, \ t_0 = \frac{s_0 + a_0}{a_0 v}\ x \qquad (3)$$

Here $a_0$ and $s_0$ refer to the concentrations per unit volume of sorbent column, $t$ is the time, $v$ the velocity of flow, $x$ the length of column, $\alpha$ and $\beta$ are defined by (1), and $k'$ and $t_0$ are derived constants defined by (3) The formula (2) proved to describe very well a large number of runs made each at a constant $v$, $k'$ proved to be proportional to $\sqrt{v}$ [1]

During the War, Nachod and Wood[4], Thomas[5], and Walter[6] independently assumed a bimolecular mechanism for the ion exchange process Thomas derived a rather complicated solution of the differential equations for the general case, and Hiester and Vermeulen[7] showed an ingenious way of making practical calculations with Thomas's equations by means of diagrams of suitable auxiliary functions However, if the added ion is more strongly sorbed, the 'leaking curve' so quickly approaches our formula (2) that it may perhaps be unnecessary for most practical purposes to use more elaborate expressions

We have also been studying the opposite phenomenon, where an ion exchanger, saturated with silver ion, is percolated with a solution containing hydrogen ions We were able to measure the amount of silver ion leaking out accurately down to $\alpha = 10^{-3}$ The results, especially for lower values of $\alpha$, certainly cannot be reconciled with any formula assuming the same bimolecular constants of $k$ and $k_1$ as were found in the first-mentioned experiments, or with any other set of constants $k$ and $k_1$

That this must be so became evident from equilibrium measurements If $k$ and $k_1$ were constant, the 'mass-action law constant'

$$K = \frac{\beta(1-\alpha)}{\alpha(1-\beta)} \qquad (4)$$

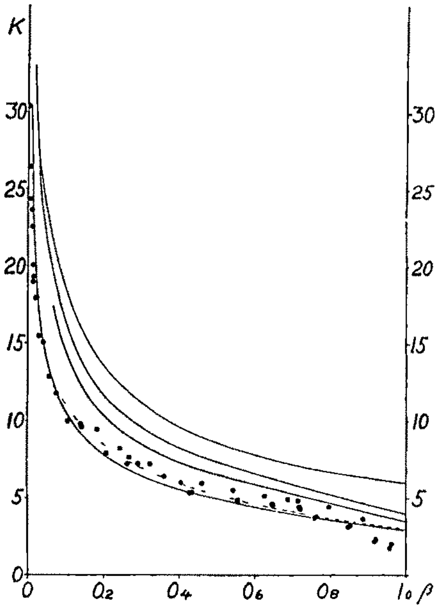
should be constant $K = kk_1^{-1}$ For real ion exchangers, the apparent $K$, however, varies greatly with $\beta$ In the accompanying graph the black dots are static measurements of $K(\beta)$ with the ion exchanger 'Wofatit *KS*', $K$ is seen to vary from values around 3 for $\beta \approx 1$ (almost only Ag$R$) to around 30 for low $\beta$ (almost only H$R$) For 'Dowex 50', a curve with a minimum was obtained

One might suggest that the ion exchanger contains a number of different types of sites, each with its individual $K$ However, no such explanation would explain the curve with a minimum in $K(\beta)$

Whatever the explanation may be, there seems to be no foundation for the use of constants $k$ and $k_1$ in (1), at least for the broadening type of front For the constant form front, it still seems to give a very good approximation

Since this kinetical approach did not seem very promising, we instead tried an approximate assumption that, in our elution experiments, equilibrium had at all points been attained between sorbent and solution To our measurements of the silver fraction $\alpha$ in the effluent solution at various times we applied the equation

$$\beta = 1 - \int_{\alpha}^{1} \psi\, d\alpha. \qquad (5)$$



Apparent equilibrium constant $K$ of ion exchange $Ag^+ + HR \rightleftarrows H^+ + AgR$ as function of $\beta$, the 'silver fraction' in the ion exchanger Black dots static measurements Curves calculated from elution experiments by means of formula (5) From above, velocities 70, 18, 9, 2, 1 ml /min The two latter curves almost coincide, that for 2 ml /min is dotted

The results from a number of runs at different velocities of flow are plotted in the graph They are not given in the usual isotherm form, $\beta$ *versus* $\alpha$, since this mode of representation would crowd the curves and points too much together We have preferred to give the apparent equilibrium constant $K$ as a function of $\beta$, the silver fraction in the ion exchanger, since this type of diagram is much more sensitive to small differences, of course, the experimental errors also show up much more The curves for the velocities 70, 18 and 9 ml /min are higher than the values obtained at static equilibrium runs, but the curves are seen to approach to the static values with decreasing velocity of flow For the lowest two velocities, 2 and 1 ml /min, the curves from the elution experiments lie amid the static points, actually the curve for 2 ml /min is sometimes a little bit lower than that for 1 ml /min, which may be ascribed to experimental errors

From the graph we would like to draw two conclusions First, at the lowest velocities of flow the approach to equilibrium seems to be so good that the adsorption isotherm or the equivalent $K(\beta)$ can be obtained from dynamic experiments with the aid of formula (5) with no less accuracy than from static measurements The dynamic experiments, of course, are much less laborious than the static ones The runs at the lowest two velocities, each of which gave us a complete curve $K(\beta)$, took 28 and 32 hr respectively The work was much aided by automatic recording devices, so there was no need for watching the apparatus all the time The calculations according to (5) took something like ten hours On the other hand, to obtain all the points marked in the graph from static experiments, more than three months work was needed, representing something like six hundred hours work If in the future we wish to determine equilibria of ion exchange, we shall probably prefer to do it by the dynamic method In many cases where potentiometric methods cannot be applied, optical or conductometric methods may be suitable

Secondly, although the upper curves in the graph certainly do not represent equilibrium states, the curves of the apparent $K(\beta)$ are a very compact way of representing the whole course of the elution curve It occurs to us that in the case of spreading fronts, even if equilibrium is actually not reached, a very useful approximation to the elution curve could be obtained by using 'false isotherms' or false $K(\beta)$ curves like the upper ones in the graph

A more detailed account of this work will be given elsewhere

*Note added in proof* The equilibrium quotient in (4), which has been called $K$ in this article, we would now prefer to denote by $\varkappa$ to prevent confusion with the thermodynamic quantity (*Acta Chem Scand*, 4, 556, 1950)

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[1] Sillén, L G, and Ekedahl, E, *Arkiv Kemi*, **22A**, No 16 (1946) Ekedahl, E, and Sillén, L G, *Arkiv Kemi*, **25A**, No 4 (1947)
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[5] Thomas, H C, *J Amer Chem Soc*, **66**, 1664 (1944)
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# PHOTONS AND WAVES*

By Dr D. GABOR

Imperial College of Science and Technology, London

THE dual nature of light manifests itself most strikingly in Einstein's equation[1] for the mean square fluctuation of radiant energy in thermal equilibrium

$$\overline{\delta\varepsilon_T^2} = \overline{(\varepsilon_T - \bar{\varepsilon}_T)^2} = h\nu\bar{\varepsilon}_T + \bar{\varepsilon}_T^2, \qquad (1)$$

where $\varepsilon$ is the energy in the system considered, per unit frequency-interval at some frequency $\nu$, the suffix $T$ relates to thermal equilibrium, bars over the symbols stand, as usual, for mean values It is well known that the second term on the right-hand side can be interpreted as resulting from the interference of the *waves* by which the energy is represented classically, while the first term is the same as if the energy were concentrated in $\overline{N}_T$ *photons*, $\bar{\varepsilon}_T = h\nu\overline{N}_T$, the number of which fluctuates by the same law as if they were independent particles

Einstein's equation is fundamental also for the theory of electrical communications Whether wires are used in the transmission or not, by Maxwell's

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* Abstract of some parts of a lecture entitled "La Théorie des Communications et la Physique" in a series of lectures on communication theory organised by M Louis de Broglie, delivered in Paris on May 9

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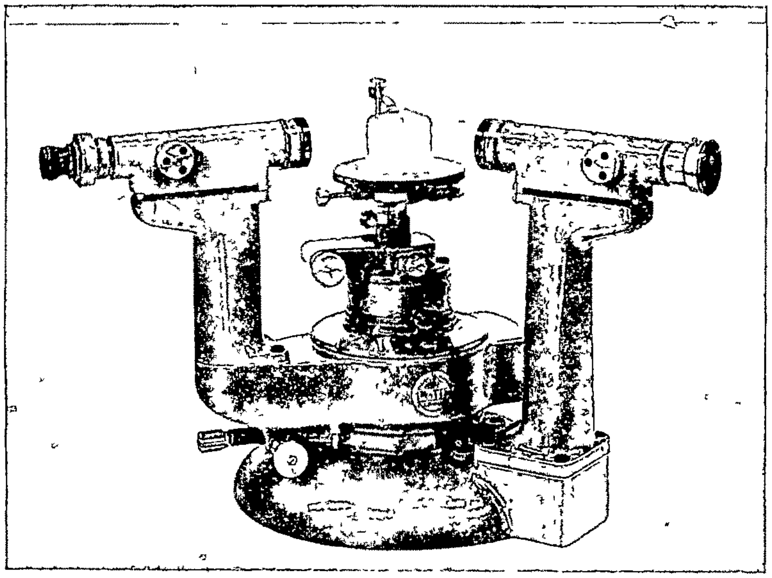

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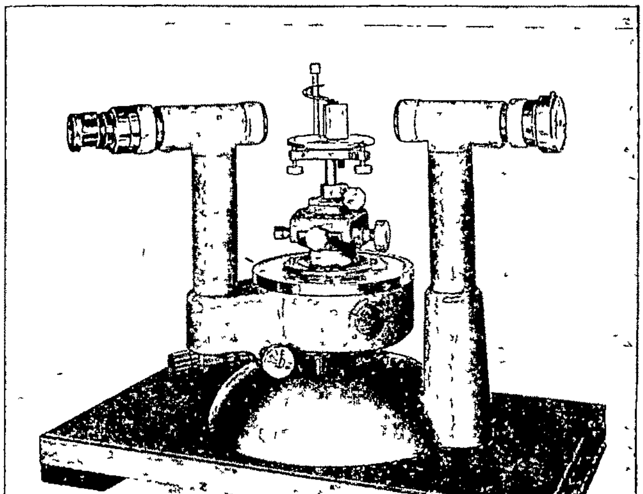

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theory the energy is always transmitted through empty space, that is, by radiation, hence equation (1) is the physical basis of thermal noise in electrical communication systems But noise is the fundamental physical limitation of any communication channel in transmitting information, hence ultimately it sets also the limit to what we can learn quantitatively about physical phenomena

Equation (1) shows clearly two sources of noise one arising from the indefiniteness connected with the concept of temperature, the other from the finite size of quanta A third source arises in the interaction of radiation with matter from the finite size of the elementary electric charge Between them these three sources of noise or uncertainty set the limits by which we can empirically define concepts such as 'waves' or 'photons'. It is generally believed that these two methods of description become equivalent at very great quantum numbers It will be shown that though this is approximately true, the classical method is always slightly inferior to the quantum description as regards *quantitative information content*

In communication problems, it is convenient to take as the unit of discussion the 'information cell', with a frequency width $\Delta\nu$ and a time interval $\Delta t$, so that

$$\Delta\nu\,\Delta t = 1 \qquad (2)$$

It has been shown[2] that each information cell can be associated in various ways with two degrees of freedom, one of which is an amplitude, the other a phase One way of describing a signal is to associate a Planck oscillator with every information cell, and to specify its state In this article, from here onwards, $\varepsilon$ and $N$ will relate to the energy and photon content of *one* information cell If there is no signal present, and the whole communication system is at a temperature $T$, we have, by Planck's formulæ,

$$\bar{\varepsilon}_T = h\nu\Big/\left(\exp\frac{h\nu}{kT}-1\right),\quad \bar{N}_T = 1\Big/\left(\exp\frac{h\nu}{kT}-1\right) \qquad (3)$$

If there is a signal, so that the mean energy $\bar{\varepsilon}$ exceeds $\bar{\varepsilon}_T$, one deduces, by exactly the same arguments which led Einstein to equation (1)

$$\overline{\delta\varepsilon^2} = \varepsilon(h\nu + 2\bar{\varepsilon}_T) - \bar{\varepsilon}_T^2,$$
$$\overline{\delta N^2} = \bar{N}(1 + 2\bar{N}_T) - \bar{N}_T^2 \qquad (4)$$

The second formula gives the fluctuation of the photon number $N$ in the cell

We can use this formula for constructing a scale or 'ladder' of distinguishable signals, making each step of the ladder equal to the root mean square fluctuation at that level With this convention, and neglecting the last term in equation (4), which becomes unimportant at appreciable signal-levels, we find that below a level $N_m$ we can distinguish the following number $S$ of steps

$$S = \int_{N_T}^{N_m} \frac{dN}{(\overline{\delta N^2})^{1/2}} = \frac{2N_m^{1/2}}{(1+2\bar{N}_T)^{1/2}}. \qquad (5)$$

The state of the cell cannot be specified closer than to the nearest rung It may be noted that $S$ increases not with $N$ but with its square root. Using the $S$- or $N^{1/2}$-scale, we can describe completely any signal, as illustrated in Fig 1, by associating an integer with every cell, giving the position of the signal on the ladder

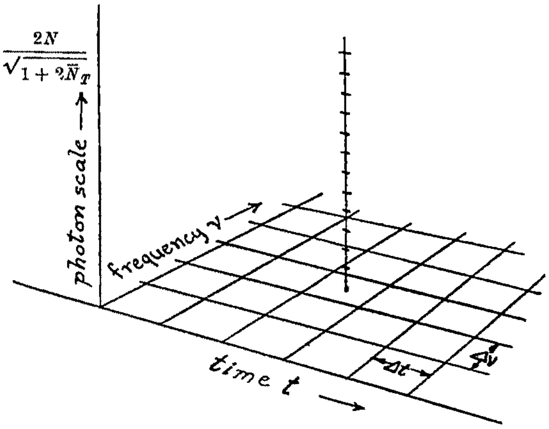

Fig 1 Representation of a signal on the photon scale

Comparing this with the classical method of description[2] in which every cell had *two* data associated with it, an amplitude and a phase, it might appear that we have lost one degree of freedom We have now only one datum, of the nature of an amplitude, but no phase Yet by the quantum method of description we have gained rather than lost information We shall show that if we carry out the classical type of analysis with a suitable device, associating $S_1$ steps with the amplitude of the signal, and $S_2$ steps with its phase, the product $S_1 \times S_2$ will be, in fact, always *smaller* than $S$

The first problem is to work out the distinguishable steps in measuring the amplitude of an electric signal, up to a level of $\bar{N}$ photons per cell In practice, if we want to measure a weak electric signal, we make the field interact with electrons, and amplify the electron current We choose for the discussion a special model of such a detector and amplifier, but it will be shown that in the case of optimum performance, we reach a limit which is quite independent of any special feature of our model Thus we may consider the result as more general than the derivation

Assume that we introduce the signal, which occupies a waveband $\Delta\nu$, into a wave-guide as shown in Fig. 2, and we explore its field by shooting an electron beam across the guide, in the direction of the electric vector The signal will produce velocity modulation in the electron beam, and this can be translated, by well-known means, into current modulation

(Quantal energy exchange between electrons and the field in a wave-guide at high quantum numbers has been previously discussed by Lloyd P. Smith[3], but I cannot agree with most of his results Monokinetic electrons and exchange of sharply defined quanta on one hand, well-defined

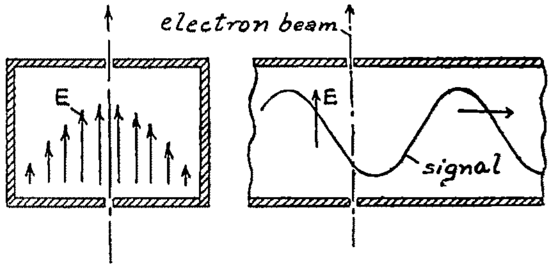

Fig 2 Exploring a signal in a wave-guide by an electron beam

entrance phases and short transit times on the other, are mutually exclusive phenomena by the uncertainty relation, hence I believe that only certain averages over Smith's detailed results have physical significance.)

Let us adjust the beam current so that in the mean $\overline{M}$ electrons cross the guide during the time $\Delta t = 1/\Delta\nu$ in which one information cell, containing in the mean $\overline{N}$ photons, passes through a cross-section. We can consider as the essential quantity the positive number $\bar{n}$, which is the mean number of quanta, $h\bar{\nu}$, exchanged between the electrons and the photons, irrespective of the sign of the exchange. It is this number which determines the character of the process. If $\bar{n}$ is large, the phenomenon will be essentially classical. Only this case will be discussed here, as amplitude and phase can be defined with some accuracy only in the quasi-classical region. The extension to small $\bar{n}$'s and the detailed calculations will be given elsewhere[4].

On the expectation, which will be confirmed *a posteriori*, that the accurate determination of amplitude and phase requires intense interchange, we try to make $\bar{n}$ at given photon number $\overline{N}$ as large as possible. We can do this, first by slowing down the wave, thus increasing the field intensity, secondly by choosing the most advantageous transit time. But the smallest group velocity which we can allow is the one at which the signal is just cut off at the low-frequency end of the wave-band $\Delta\nu$. The best transit angle relative to the mean frequency $\bar{\nu}$ is found to be 134°. Taking these into account, one obtains for the best possible interchange the relation,

$$\bar{n}^2 = \frac{1.5}{137}\left(\frac{v}{c}\right)\left(\frac{\Delta\nu}{\bar{\nu}}\right)^{1/2}\overline{N} \tag{6}$$

In this formula, valid for large photon numbers only, all special features of the model have disappeared. $v$ is the velocity of the electrons, $c$ the velocity of light, $137 = hc/2\pi e^2$ is the fundamental number which links electrons to photons. It is evident that the factor of $\overline{N}$ in equation (6) is always very small, though, as will be shown below, in the optimum case it must be made equal to unity. But it is possible, at least in theory, to make the electron pass repeatedly, say $P$ times, through the guide, always in the right phase. (In practice, one would rather replace the wave-guide by a 'high-$Q$' resonator.) $P$ can be made large, of course, only if the wave-band is very restricted, otherwise one could not fix the mean frequency of the signal beforehand with any reliability. The interesting result follows, that the classical analysis can be carried out with optimum accuracy only if one decomposes the signal from the start into narrow wave-bands—a direct consequence of the smallness of the interaction parameter 1/137.

Assuming now that we can make the coefficient of $\overline{N}$ in equation (6) as large as we like, what is its optimum value? The quantity to be measured is the mean electric amplitude in the information cell, and this is proportional to the square root of the photon number. The measured quantity, on the other hand, is the alternating electron current, and it is known from the theory of velocity-modulation devices that this is proportional to $\bar{n}\,\overline{M}$ for weak signals. For the optimum we impose the criterion that the relative mean square deviation of the quantity measured from the quantity to be measured shall be as small as possible, that is,

$$\frac{\overline{(nM - CN^{1/2})^2}}{(\overline{nM})^2} = \text{minimum} \quad (7$$

The most suitable constant $C$ itself is to be determine from the condition

$$\overline{(nM - CN^{1/2})} = 0 \quad (8$$

The problem is how to choose $\bar{n}$ and $\overline{M}$, that is interchange parameter and electron current so as t satisfy the condition (7). We give here only th physical basis of the calculation. Too weak a interchange would leave the cell unexplored. To strong an interchange, on the other hand, will interfere with the object of measurement, because, though in the mean an electron is as often accelerated as retarded, fluctuations in the number of electrons which pass through accelerating or retarding phases might produce extra photons, which could not be distinguished from those belonging to the signal, o annihilate some. Similarly, too weak a current will produce a large 'shot effect'; too large a current will again spoil the object. It may be noted that we have here a type of uncertainty which springs directly from the fact that photons and electrons are discrete, without any reference to the physical values of $h$ or $e$. This is confirmed by the calculation, which, assuming 'normal' shot effect and introducing some evident assumptions about the mutual independence of $n$, $M$ and $N$, such as $\overline{nM} = \bar{n}\,\overline{M}$, gives

$$\frac{\overline{nM - CN^{1/2})^2}}{(\overline{nM})^2} = \frac{1}{4\overline{N}} + \frac{1}{\bar{n}} + \bar{n}\left(\frac{1}{\overline{nM}} + \frac{\overline{nM}}{4\overline{N}^2}\right) \tag{9}$$

This is a minimum if

$$n^2 = \overline{N},\quad \bar{n}\,\overline{M} = 2\overline{N}, \tag{10}$$

hence $\overline{M} = 2\overline{N}^{1/2}$, which gives the simple rule that for optimum analysis one must take one exploring electron for every step in the scale of photons, and the interchange $n$ must be itself equal to one distinguishable step. The relative uncertainty in measuring the amplitude now becomes, neglecting the first small term at the right-hand side of equation (9), equal to $(2/\bar{n})^{1/2} = 2^{1/2}/\overline{N}^{1/4}$. This is $\sqrt{2}$ times larger than the square root of the relative uncertainty in the scale of the photons. This proves that the ladder of the amplitudes will contain always less steps than $\sqrt{S}$, according to equation (5); apart from the factor $\sqrt{2}$, for the reason that the optimum setting is possible only for one level, for example, for the maximum level to be expected, for weaker signals the uncertainty will be necessarily more than the minimum. A similar argument applies to the measurement of the phase. Summing up, we see that the classical description of the signal, in terms of amplitude and phase, by being too detailed, gives, in fact, a smaller number of ascertainable data on the signal than the quantum description—in the useful terminology of D. M. MacKay[5], it has a smaller 'metron-content'.

The difference, though theoretically interesting, may be of small importance practically, particularly if we take into consideration that we have really compared a classical exploring device with an ideal photon counter. But such counters are not available in the range of frequencies used for electrical communications, hence in this region classical detectors may well be the best. Things are different in the optical region, where detectors of the 'counter' type —such as the eye—are approaching perfection. In this region analysis in terms of waves is as yet technically impossible, but it is interesting to note that, even if it were possible, it would not be very practical. It takes about one hundred million photons per information cell in order to define amplitude and phase to 1 per cent each. In the visible region, this means already signals of very appreciable intensity.

These considerations suggest that the idea of information, which originated in the theory of communications, may well prove a fruitful concept when applied to physics.

---

[1] cf. Born, M., "The Natural Philosophy of Cause and Chance", 81 (Oxford, 1949).

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# MASSES OF FUNDAMENTAL PARTICLES

By Dr. R. FURTH
Birkbeck College, University of London

IN a recent note, Flint[1] suggested that the "fundamental length" $h/m_pc$ should be identified with the classical radius of the electron $ke^2/m_ec^2$ (where $m_p$, $m_e$ are rest masses of proton and electron, and $k$ is a universal, dimensionless constant), both having the meaning of ranges of nuclear forces. This leads at once to the expression

$$\mu \equiv \frac{m_p}{m_e} = \frac{ch}{ke^2} = \frac{2\pi}{\alpha k} \equiv a \qquad (1)$$

(where $\alpha$ is the fine-structure constant) for the mass ratio of proton and electron. He showed that this relation is satisfied with a remarkable accuracy if the value $k = 15/32$ is used which I derived from theoretical considerations in a paper[2] in which expression (1) was first deduced from a new basic principle. In the present communication I wish to show that this principle can be generalized in such a way that it not only yields the mass ratio $\mu$, but also the electronic mass numbers of all the other hitherto observed fundamental particles in terms of pure numbers, without the introduction of any arbitrary constants. This is not the case with various other suggestions[3] of a purely empirical character for deriving these mass ratios.

The new principle can be expressed in the following propositions.

(I) The fundamental length or 'radius' to be associated with a neutral particle of rest mass $m_0$ is its 'Compton wave-length', $h/m_0c$.

(II) For a particle of zero rest-mass (photon) the corresponding length is equal to the wave-length $\lambda = c/\nu$.

(Propositions (I) and (II) follow directly from my "hypothesis of elementary indeterminacy"[3].)

(III) The 'radius' of a charged particle of rest-mass $m_0$ is equal to $ke^2/m_0c^2$ with $k = 15/32$.

(IV) The radius of a neutral nucleon is identical with the range of its nuclear field[4,5].

(V) In a process of transmutation of fundamental particles, the 'radii' of the primary and secondary particles satisfy the equation

$$\sum_i \delta_i r_i = 0 \quad \text{with} \quad |\delta_i| = 1,$$

in which the expressions (III) are to be used for particles interacting electromagnetically, and expressions (I) and (II) in all other cases.

(According to the hypothesis of elementary indeterminacy, the product of the 'radius' and the 'fundamental momentum' associated with a particle is equal[2] to $h$. Hence proposition (V) is 'reciprocal' in the sense of Born's theory[6] to the law of conservation of momentum.)

Consider first the process of β-decay, that is, the transmutation of a neutron into an electron and a proton. Here we have

$$\frac{h}{m_nc} + \frac{ke^2}{c^2}\left(\frac{\delta_1}{m_e} + \frac{\delta_2}{m_p}\right) = 0 \qquad (2)$$

(where $m_n$ is mass of neutron), which is to be combined with the energy equation

$$m_nc^2 = m_ec^2 + m_pc^2 \qquad (3)$$

Taking into account that $a \gg 1$, one can easily show that the only admissible solutions of (2) and (3) are

$$\mu = a \quad \text{and} \quad \mu = 1/a$$

They are, of course, equivalent and mean that the two secondaries must have a mass ratio which, with Eddington's value $\alpha = 1/137$ of the fine-structure constant, can be expressed as a pure number, namely,

$$\mu = \frac{2\pi \times 32 \times 137}{15} = 1836{\cdot}4 \qquad (4)$$

(observed value, 1836·57).

Relations (2) and (3) also hold for the process of the decay of a proton into a positron and a neutron, and therefore the principle demands that the masses of electron and positron be practically identical.

The result (4) is also compatible with the transmutation of a neutron into a positron and a 'negative proton' or 'antiproton', which would have to have the same mass as the proton. This consequence of the theory was pointed out by me in a paper published in 1933[7], and later the possibility of the existence of a negative proton was repeatedly discussed by a number of physicists[8], apparently without knowledge of that publication. It was further pointed out in that paper that in a closed part of the universe only one sort of positive and one sort of negative stable fundamental particle could exist simultaneously, because pairs of electrons and positrons, and also pairs of protons and antiprotons, would continue to annihilate each other until only one type of light particle and one type of heavy particle with opposite charges would survive. However, the possibility of an occasional creation of antiprotons (with very short life-time) is indicated by the argument in (3).

Proposition (IV), combined with Yukawa's expression $h/2\pi m_\pi c$ for the range of nuclear forces due to the presence of 'nuclear mesons' of mass $m_\pi$, leads to[4]

$$\frac{m_n}{m_\pi} \approx \frac{m_p}{m_\pi} = 2\pi. \qquad (5)$$

If (5) is combined with (4), the electronic mass number of the 'π-meson' can be expressed in terms of pure numbers

$$\frac{m_\pi}{m_e} = \frac{32 \times 137}{15} = 292 \text{ (observed value, } 285 \pm 5) \qquad (6)$$

Next consider the interaction of a τ-meson with a neutron, resulting in the formation of a secondary (μ-) meson. This can be regarded as a transmutation of two primary particles with masses $m_n$, $m_\pi$ into two secondary particles with masses $m_n$, $m_\mu$. From (V) we have

$$\frac{h}{m_n c} + \frac{\delta_1 h}{m_\pi c} + \frac{\delta_2 h}{m_n c} + \frac{\delta_3 h}{m_\mu c} = 0 \qquad (7)$$

It can easily be verified that the only solution of this equation compatible with the condition $\varepsilon \equiv \frac{m_\pi}{m_\mu} > 1$, is

$$\varepsilon = 1 + 2\,\frac{m_\pi}{m_n} \qquad (8)$$

If this is combined with (5), one obtains

$$\varepsilon = 1 + \frac{1}{\pi} = 1\ 32 \text{ (observed value, } 1\ 33 \pm 0\ 05), \qquad (9)$$

a relation which was first derived by me from a less general consideration[4]

From (6) and (9) follows the value for the electronic mass number of the $\mu$-meson

$$\frac{m_\mu}{m_e} = \frac{292}{1\ 32} = 221 \text{ (observed value, } 216 \pm 5) \qquad (10)$$

Consider finally the process of annihilation of a proton and an antiproton The annihilation of an electron and a positron results in the formation of two equal photons I suggest that the annihilation of a proton and an antiproton, as this involves electromagnetic and nuclear interaction fields, results in the creation of a pair of photons and a pair of neutral mesons ('neutrettos') or charged mesons

In the first case, we may replace the process by two identical processes of transmutation of a neutron into a photon and a neutretto of mass $m_\tau$ For this, proposition (V) provides the equation

$$\frac{h}{m_n c} + \frac{\delta_1 c}{\nu} + \frac{\delta_2 h}{m_\tau c} = 0, \qquad (11)$$

to which has to be added the energy relation

$$m_n c^2 = h\nu + m_\tau c^2 \qquad (12)$$

It can again easily be shown that the only possible values for the energy ratio $\eta \equiv \frac{m_\tau c^2}{h\nu}$ of neutretto and photon, resulting from this equation, are

$$\eta = \frac{1+\sqrt{5}}{2} = 1\ 618 \text{ and } \eta' = \frac{\sqrt{5}-1}{2} = \eta - 1 = \frac{1}{\eta} \qquad (13)$$

Thus the two types of created particles have the fixed energy ratio $\eta$

From (12) and (13) one obtains two possible values for the mass ratio $m_n/m_\tau$, namely,

$$1 + \eta = 2\ 618 \text{ and } 1 + \eta' = \eta = 1\ 618,$$

from which by means of (4) the electronic mass numbers of the two possible neutrettos are calculated

$$m_\tau/m_e = 701 \quad \text{or} \quad m_\tau/m_e = 1{,}135 \qquad (14)$$

I venture to suggest that such a neutretto can in turn produce a pair of $\tau$-mesons by interaction with a nucleon, in analogy to the process of 'pair-production' by a photon, and that this is the process first described by Rochester and Butler[9] and more recently by Anderson and collaborators[10] in what they call "decay of the first kind"

If, on the other hand, the annihilation process of proton and antiproton results in the creation of a pair of charged mesons, it cannot be split up into two symmetrical halves as considered above, and hence the present theory is not capable of predicting the masses of these mesons It seems not unreasonable, however, to assume that these mesons may have a continuous mass spectrum within the limits of (14) They could therefore be identical with the so-called $\tau$-mesons which have been described by various observers[11], indeed, the most recent determination of the masses of these particles by Butler, Rosser and Barker[12] gives the limits 650–1,140 $m_e$

The process of the transmutation of a $\tau$-meson into a lighter particle, first observed by Rochester and Butler[9] and more recently by Anderson and collaborators[10], in their "decay of the second kind" process, may well be analogous to the transmutation of a $\pi$-meson into a $\mu$-meson The mass $m_\tau'$ of the secondary particle would then, according to (8), be given by

$$\frac{m_\tau}{m_\tau'} = 1 + 2\,\frac{m_\tau}{m_n} \sim 2. \qquad (15)$$

As I have already emphasized elsewhere[5], it is indeed in keeping with the principles of the present theory to ascribe a continuous mass spectrum to mesons in analogy to the continuous frequency spectrum of photons The appearance of mesons with specific rest masses must be regarded as the outcome of specific nuclear processes, just as the appearance of specific spectral lines is the outcome of specific electronic processes in the atomic shells

[Aug 7

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# MARINE BIOLOGY RESEARCH IN GREAT BRITAIN

NINETEEN papers on the physical and chemical properties of sea-water, movement of water on the ocean bed, and the life-history and habits of the animals living in the sea, make up a well-balanced group in the December issue of the *Journal*, issued by the Marine Biological Association of the United Kingdom

A second paper by Mr G A Steven on the biology of the mackerel (*Scomber scombrus*) is based largely on observations and plankton samples collected by fishermen engaged in the Newlyn deep-sea mackerel fishery, sole relic of the three West-Country fisheries, for the inshore Newlyn and Plymouth fisheries are no longer remunerative P G Corbin (1947) mapped the spawning areas in the Celtic Sea, north-west and south-west of the Cornish peninsula, and Steven found that the most productive fishing areas lie on the fringes of those areas nearest to the land, from about one hundred miles west of the Scillies in March, and moving shorewards as the fish rise from the sea bed and migrate to shallower waters for active feeding The post-spawning anadromous migration is correlated with the 'yellow water' recognized by the fishermen, and this proved on investigation to be water rich in zooplankton, particularly copepods

Mr Corbin contributes his tenth paper on the seasonal abundance of young fish, for the year 1948 A continuation of the decline in the population of young fish, coupled with that of the planktonic organisms on which they feed, is in great contrast to the rich hauls of the year 1930, and the fortnightly averages of some species are now so low that they cannot be graphed against similar averages for the period 1930–34 Clupeids provide the highest figures, particularly in March and October None was recorded in November, the only month in which they were absent The haul of pilchard eggs in June was barely one-third that of a good year Plankton other than young fish were also scarce *Calanus*, *Sagitta setosa* and *Muggiœa atlantica* show very low records

The link between the larval stage and the adult form, so ably worked out in many species by Dr Marie Lebour, is the subject of three papers in the present issue One, by Dr Lebour herself, deals with the last larva and post-larva of *Typton spongicola* This peculiar deep-orange larva was taken off the Eddystone, and changed in the laboratory to the post-larva, with loss of its double flexion but retention of the humped abdomen The antennal scale and the exopodite of thoracic appendages 4–7 show a progressive decline from larva to adult Nothing is known of the transition from the free post-larva to the sedentary adult living within a sponge A similar post-larva was found in Bermuda in 1940 by Dr Hilary Moore

Mr R H Millar describes the larval stage of *Didemnum maculosum*, a compound ascidian forming mouldy-looking incrustations on *Laminaria* roots in the littoral zone The larva possesses four rows of stigmata and other pharyngeal characteristics of the adult zooid of the family Didemnidæ, but has only two anterior adhesive organs as in *Trididemnum alleni*

Our knowledge of the life-history and local distribution of *Arenicola marina* has expanded considerably during the past few years, owing to the careful and intensive studies of G P Wells, G E Newell and G Chapman In the present number the last two authors have worked out that the population density of lugworms in inter-tidal zones with high organic content depends upon particle size and depth of the 'top-soil' Worms do, however, migrate from less to more favourable areas, especially in spring In this way they came to inhabit a large mine crater on the Whitstable flats which had afterwards filled up with soft sandy mud in a bowl of clay Dr Newell was the first to discover the spawning and the early larval stages of *Arenicola marina* in Great Britain, and he now follows up the life-history by a study of the development between the larva with three chætigerous segments and a post-larva, about 3 mm long, with twenty chætigerous segments and six eyes, but no branchiæ These post-larval stages are bottom dwellers enclosed in mucous tubes on pebble and *Fucus* zones, the habitat bearing out Newell's earlier suggestion that the lugworm has no pelagic stage in its life-history

As a foretaste of the eagerly awaited Ray Society monograph on the Mysidacea by the late Prof W M Tattersall, which Mrs Tattersall has prepared for the press, she gives a key for the mysids of the Plymouth area, which will prove useful to those of us who supplement daytime plankton hauls with coarse-net hauls at night

The invasion of British shores by Mediterranean species occasionally occurs, and Miss U M Grigg describes the recent appearance of two large southern species of sea hares, *Aplysia depilans* and *A limacina*, the former from Babbacombe and the latter from the Salcombe estuary This is the third record from various points on the south coast of *A depilans*, but the first of *A limacina* Dr D P Wilson contributes beautiful photographs of the living animals

Mr G M Spooner investigated the absorption of strontium and yttrium by algæ, and found that radioactive strontium was taken up by brown seaweeds, *Fucus serratus* containing forty times as much as in sea-water, and about three times as much as *Laminaria digitata* Red and green algæ absorb a negligible amount, *Rhodymenia* and *Ulva* containing less than in the sea Radioactive yttrium is in inverse proportions, being least in the brown weeds It is suggested that there is both ionic exchange and adsorption on surfaces, but in brown algæ primarily ionic exchange *Nitzschia* takes up yttrium very heavily, probably by adsorption on the surface

A preliminary article on volume measurement of water filtered by a plankton pump is contributed by Mr H Barnes, who uses an ex-National Fire Service pump, tests it by filling a tank and estimates the pumping-rate, filtering off the plankton would probably increase the accuracy He suggests that the variability of net hauls is not entirely due to variation in the volume of water filtered, but this requires further investigation

Dr A A Aleem describes an ingenious apparatus for producing artificial tides in an inverted bell-jar by a drip-siphon method, which can be adjusted to give two high and two low tides within twenty-four hours In a second paper he details a method for estimating quantitatively the periodicity of epiphytic marine diatoms by computing the amount of diatom silica, after washing free from sand The method can be adapted for planktonic diatoms, provided that the sample does not contain other organisms having a siliceous envelope

Dr W A P Black and Dr E T Dewar have worked on the correlation between some of the physical and chemical properties of the sea and the chemical constitution of the algæ The samples of sea-water from three localities on the Argyllshire coast do not differ materially from those elsewhere as regards estimations of *p*H, dissolved oxygen, nitrate and phosphate, in the different months of the year, August having the lowest record, though it has the highest temperature Using species of *Laminaria* for the estimation of their chemical constituents, they found that a correlation does exist and that rapid photosynthesis occurs from March to early July, when nitrate and phosphate are plentiful, and are at their lowest in late July and August, but rise again in the autumn after vertical mixing and regeneration of the nutrients

There are two papers on measurements of extinction coefficients A quick method, taking only five minutes, for the determination of visibility depth in water, using selenium rectifier cells and colour filters, is described by Dr W R G Atkins, Dr H H Poole and Mr F J Warren, while Mr M H W Gall gives an account of his cruise in the North Sea and English Channel, during which extinction coefficients were determined at twenty-five stations, compared with

Secchi disk readings, and correlated with salinity and temperature

Finally, an interesting paper on water movements, entitled "Cascading over the Continental Slope", by Dr L H N Cooper and Mr D Vaux, deals with the cooling and sinking of the surface water in some winters over the Celtic Sea to a depth of about a hundred fathoms This heavy water, coming into contact with the sea bed of the continental shelf, moves down it and flows along the bottom to the greater depths beyond Mr G A Steven has suggested the term cascading for this movement, which the authors believe occurs in limited areas only Cascading will convey not only oxygen and nutrients to the depths, but also phyto- and zoo-plankton, which may in turn affect the fish population Local cascading over flat-topped banks on the continental shelf during autumn cooling may favour the concentration of fish over declivities Compensation is brought about by inflow from the Atlantic surface-water, the North Sea and the Straits of Dover contributing little or none

A supplementary list of insects and arachnids from the Plymouth shore areas has been added by Mr R E Hall and Mr H C Fountain

N B EALES

# FIFTH INTERNATIONAL CONGRESS FOR MICROBIOLOGY

THE fifth International Congress for Microbiology was held at Rio de Janeiro during August 17–24 On the evening before the Congress proper, an exhibition of microbiology, parasitology and hygiene was opened at the Ministry of Education and Public Health by the Minister, Dr Pedro Calmon In the same room there was the Palais de la Découverte exhibition on the "Life and Works of Pasteur" the French Ambassador was present and an address was given by Prof René Farbe

The first business on the morning of August 17 was the registration of members, and there followed a collective reception by the Minister

In the afternoon the members were received at Catate Palace by His Excellency the President of the Republic, General Enrico Gasper Dutra, and then the Congress was formally opened at the Municipal Theatre, the President and many of his ministers being among those on the platform Among others, the President of the Congress, Dr Olympio da Fonseca, made a speech After the opening session, members were taken to the Hotel Quintandinha and Petropolis, about forty miles away The former served as headquarters for the Congress It was most convenient for the majority to be housed and have their meetings in the same building As it is 2,600 feet above sea-level the temperature was much more conducive to work than at Rio

The programme was divided into eleven sections 1, Microbiology, 2 (*a*) Medical, and (*b*) Veterinary Bacteriology, 3, Virus and Virus Diseases, 4, Rickettsiæ and Rickettsial Diseases, 5, Mycology, 6, Protozoology, 7, Plant Pathogenic Micro-organisms ; 8 (*a*) Water, Sewage, and (*b*) Soil Microbiology, 9, Industrial Microbiology, 10, Immunology and Allergy, and 11, Classification and Nomenclature of Micro-organisms The sessions were held from 9 a m until 1 p m. on Friday, Saturday, Monday and Wednesday, the afternoons being devoted to meetings of committees and sub-committees on various subjects At 5 p m and 9 p m there were special lectures, followed by entertainment of divers kinds

The Congress was a great success in every way A volume of abstracts of papers was available on the first day and daily bulletins were issued giving changes in the programmes of different sections Arrangements for illustrating the papers were excellent

Many problems of immediate scientific interest were discussed in the different sections, as would be assumed from the grouping of the papers Some o the programmes were very full, particularly those o microbiology and mycology The first dealt mainly with matters common to all sections The success o the second was remarkable in every way All aspects of medical mycology received notice and most groups of fungi were touched upon, Coccidioides and Paracoccidioides having most attention The seriousness o deep-seated granulomas in South America and the frequency of other fungal diseases of man and animals have given mycology a prominent place i medical studies there Many of the papers presented showed a pleasing acquaintance with the requisite of classification and correct identification Medica mycology, a subject full of difficulties, has had these magnified by descriptions and drawings of fung which could have had no existence—a fact which has deterred investigations, possibly more particularly in Great Britain, where though fungus diseases are of little practical importance they are certainly not so rare as is commonly assumed There is no doubt that their importance in South America is realized and that excellent work is being carried out there. The deliberations of the section should have wide-reaching effects on medical mycology Other aspects of mycology were considered in other sections, including that of plant pathology It has been suggested that this last section should in future specialize in bacterial, protozoological and virus diseases

On Sunday, after solemn mass at Petropolis Cathedral, some members went to the Jockey Club at Rio, while others visited the National Park a Teresopolis This is one of the five Brazilian National Parks and is conveniently situated near Rio in the Organ Range One of the objects of the Park is to demonstrate how the retention of the tree cover o mountain slopes prevents soil erosion there is alarm everywhere about destructive exploitation, but apparently no unified action The entrance to the Park has been made into a garden, but there is a tendency to make too many roads, also, in view o the great natural beauty, marigolds, pinks and other common European garden plants seem out of place

Tuesday morning was spent visiting the famous Oswaldo Cruz Institute, which is celebrating its fiftieth anniversary, and of which Dr Olympio da Fonseca, the president of the Congress, is the director The scope of the investigations there being carried out is refreshingly wide and the morning proved all too short for the visit After lunch at the Institute, Prof Clementino Fraga gave a lecture at the Brazilian Academy of Letters on "Oswaldo Cruz an Interpretation of Personality" There followed a reception by the Mayor of Rio at Guanabara Palace, and a performance which included an open-air ballet,

The main part of the final day was the closing session, at which the various recommendations of committees and sub-committees were submitted for approval—one that there should be a halt in the attempts to provide complete schemes for virus nomenclature until the results of research now in progress give some sound basis for classification

An invitation to hold the next Congress at Rome in 1953 was accepted. There was a banquet in the evening, with many speeches, and the final festive occasion was a dance

Visits were arranged to places of interest, and many members flew to São Paulo after the Congress to visit the agricultural and medical institutes on Friday, and a snake farm on Saturday, followed by a barbecue J RAMSBOTTOM

# THE INSTITUTE OF PHYSICS

## ANNUAL MEETING AND REPORT FOR 1949

AT the thirtieth annual general meeting of the Institute of Physics, held on July 20 at the Institute's House, 47 Belgrave Square, London, S W 1, the following were elected to take office on October 1 *President*, Prof W E Curtis, *Vice-President*, Prof E G Cox, *Honorary Treasurer*, Mr E R Davies, *Honorary Secretary*, Dr P B Dudding, *New Ordinary Members of the Board*, Dr F P Bowden and Mr G R Noakes Prof H W Thompson joins the Board as the new representative of the Faraday Society

The thirtieth annual report of the Board, covering the work of the Institute during 1949*, was adopted at the meeting It records that the Board met six times, and its various standing committees twenty-five times, during the year Applications for membership in the various grades received during 1949 numbered 652, including 126 to the new grade of graduateship of the Institute The total membership increased by approximately 200 to 3,657 The Institute has now eight branches and seven specialist subject groups, the North East Coast Branch and the Education Group having been inaugurated in October Details of the various activities of the branches and groups are given in the report Many meetings were held and several laboratories were visited The five divisions of the Australian Branch held thirty-nine meetings and a three-day conference on X-rays in industry in Melbourne during November The Scottish Branch was responsible for a pioneer experiment in the arrangement of a course, which has attracted very large audiences, of eighteen weekly lectures on atomic and nuclear physics The Institute collaborated with the H H Wills Physical Laboratory of the University of Bristol in a summer school during September on theoretical physics, and the Stress Analysis Group was responsible for two summer schools, one at University College, London, and the other in conjunction with the Engineering Laboratory of the University of Cambridge

A new and outstanding event was the convention organised by the Institute and held in Buxton during May 19–21 Primarily a domestic affair, attendance was limited to members, members' ladies and a few distinguished guests It proved most successful More than four hundred people attended, and, in addition to social events such as the convention dinner and dance, visits to local beauty spots, places of interest, laboratories and works, symposia were held on physical analysis and testing, the development and application of X-ray analysis, and means of accelerating particles to high energies The president, Dr F C Toy, opened a discussion on "The Institute, Past, Present and Future", and Prof A M Tyndall, a past president, spoke on "Atomic Particles—a Survey of Recent Discoveries" An exhibition, consisting of photographs, models and instruments, was an additional interesting feature of the convention

The report mentions that applications from technical colleges for official recognition by the Institute as institutions suitable for the training of physicists continue to be received, and that to date twenty-eight colleges, after personal inspection by representatives of the Institute and of the Ministry of Education, have been granted official recognition Nine colleges in England and Wales have had courses approved for Ordinary National Certificates in applied physics, and arrangements have been made with the Scottish Education Department for the establishment of similar courses in Scotland

In accordance with the recommendation of its publications policy committee that the amount of the publications of the Institute should be considerably increased, arrangements were completed for the launching in January this year of the *British Journal of Applied Physics* (see *Nature*, April 29, p 679), for the publication of further volumes in the "Physics in Industry" series, and for a monthly *Bulletin*, which also commenced in January During 1949 a second edition of the "Handbook of Industrial Radiology" was published and also a selection, in book form, from the "Laboratory and Workshop Notes" which had appeared in the *Journal of Scientific Instruments* The royalties from the sale of both these books are credited to the Benevolent Fund of the Institute

It is an interesting but somewhat disturbing fact to find reported that of the 151 papers and 51 laboratory and workshop notes submitted for publication in the Institute's *Journal*, only 103 and 36 respectively were accepted and that, of these, 42 and 10 respectively required modification to meet the referees' requirements It would appear that authors need to take more care to make sure that their work is of sufficiently high merit to warrant publication and that their articles are presented in a clear and concise form and in conformity with the particular requirements of the *Journal*

The Institute continues to be represented on various joint committees and bodies Details of these are listed in the annual report, and reports of some of the representatives of the Institute are given in an appendix It is reported by the representative on the British Committee for Radiological Units that the Committee, in 1948, prepared a memorandum entitled "The Measurement of Ionising Radiations for Medical and Biological Purposes" in which it was proposed that a new unit, with the symbol *J*, be set up applicable to all ionizing radiations This memorandum has been circulated to industrial and medical radiologists for comment

The main part of the programme for the adaptation and renovation of the Institute's House in Belgrave Square was completed during the year, and the meeting and committee rooms have been in regular use Owing to the continued growth of the work at the headquarters of the Institute, the post of deputy secretary has been created by the Board, and Mr N. Clarke, who has been the assistant secretary since 1945, was appointed to the post as from January 1, this year

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* Thirtieth Annual Report of the Board of the Institute of Physics Pp ii + 12 (London Institute of Physics, 1949 )

## LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

### Rachitogenicity of Green Oats

IN 1944 it was reported[1] that young, green oats, grown in the South Island of New Zealand, appeared to be actively rachitogenic for sheep during their first winter. Further investigation[2], extending over several years and involving feeding trials with most of the commonly grown sheep fodder crops, as well as young mixed pasture and Italian ryegrass, confirmed the earlier results indicating that young green cereals (oats and barley) are strongly rachitogenic. The affected animals showed hypophosphatæmia positively correlated with the degree of rickets which developed, normal serum calcium values, varying degrees of lameness and severe retardation of growth. Chemical analysis of the green cereals invariably showed an adequate phosphorus content and a satisfactorily balanced calcium–phosphorus ratio. Vitamin D, given as cod liver oil twice weekly (45 ml. per sheep), or as a single massive dose of calciferol (25 mgm. in arachis oil), either orally or subcutaneously, was fully effective in preventing rickets and enabling a high winter growth-rate to be maintained. Calciferol in this dosage also brought about a speedy return to normal in affected sheep.

Oats were sown at this Department's farm in October 1948 and cut in April 1949, when approximately 9 in. high. A cloudy day with intermittent rain was chosen, and immediately after cutting the oats were carted to a nearby grass dryer and dried. The product, dark green and with an attractive smell, was fed to newly weaned lambs and guinea pigs.

*Analysis.* The dried oats were found to contain 11.98 gm. per cent crude protein, 1.92 gm. per cent calcium, 0.48 gm. per cent phosphorus and 0.8–1.2 I.U. per gm. vitamin D.

*Feeding.* (*a*) *Sheep.* Four newly weaned lambs of similar breeding and weight were fed to appetite on the dried green oats as their sole diet. Two of them were given a massive dose of vitamin $D_2$ (500,000 I.U. in arachis oil, subcutaneously) and two were untreated. The gains in weight of the four sheep varied between 0.29 lb./day and 0.39 lb./day, which may be considered satisfactory for sheep of this age[2]. The serum calcium values fell slightly during the experiment, but remained within the normal range. Blood inorganic phosphorus-levels also fell in all sheep, but to a greater extent.

MEAN SERUM CALCIUM AND BLOOD INORGANIC PHOSPHORUS (mgm. per cent)

| | 16/5/49 | | 11/7/49 | |
|---|---|---|---|---|
| | Vitamin D-treated | Untreated | Vitamin D-treated | Untreated |
| Serum calcium | 13.8 | 13.8 | 12.6 | 12.8 |
| Blood inorganic phosphorus | 5.4 | 5.2 | 4.7 | 3.9 |

Rickets developed in both lambs untreated with vitamin D, as revealed by radiographs and examination of sections of the costochondral junction obtained by means of rib resection at the beginning and end of the experiment. The pathological changes in the bones will be more fully described in a study of the relation of low phosphorus rickets and vitamin D in sheep, to be published elsewhere. The lambs treated with vitamin D showed these changes to a small degree; but they had only progressed to a stage which might be described as mild rickets when feeding had to be stopped because of shortage of dried oats.

During the later part of the experiment, the average consumption was approximately 800 gm. per sheep per day. This meant that each lamb was getting approximately 708 I.U. vitamin D daily, which is about five times their estimated requirement[3], yet only when this was supplemented with large additional amounts of vitamin $D_2$ could rickets be avoided.

(*b*) *Guinea pigs.* It appeared that rats were not suitable for investigating the rachitogenicity of winter green oats[4], so guinea pigs were tried.

Three groups of six newly weaned guinea pigs were used, the first two groups receiving a diet which contained 80 per cent freshly cut green oats and 12 per cent dried green oats and the third group being maintained on our stock diet. Vitamin $D_2$ was given to group 2 at the rate of 8,000 I.U. per guinea pig at the beginning of the experiment and again 47 days after. The feeding period lasted 70 days.

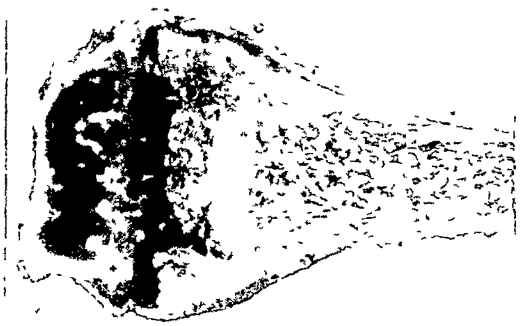
The growth-rates of the two oats-fed groups were closely comparable and not significantly less than that of the control group. The drop in blood inorganic phosphorus in the untreated oats group was, however, marked.

MEAN BLOOD INORGANIC PHOSPHORUS (mgm. per cent)

| Group | Treatment | 3/5/49 | 15/6/49 | 1/7/49 |
|---|---|---|---|---|
| 1 | Green oats | 4.2 | 1.7 | 2.2 |
| 2 | Green oats + vitamin $D_2$ | 4.0 | 2.3 | 3.1 |
| 3 | Stock diet | 4.6 | 4.8 | 4.5 |

The fall in the blood phosphorus values in the guinea pigs of group 1 coincided with the appearance of rachitic changes in radiographs of the distal epiphysis of the radius. The severity of the rickets which developed in the guinea pigs unprotected by additional vitamin $D_2$ is illustrated in the accompanying photograph.

Although autumn-sown green oats grown near Cambridge were shown to be strongly rachitogenic for sheep and guinea pigs, they have not exhibited the growth-retarding effect associated with the New Zealand green oats. Field studies in that country[2] showed that, while poor growth was certainly most



Guinea pig No. 20: rickets. Costochondral junction showing cartilage proliferation and irregularity, increased osteoid and vascularity. × 18 marked in the rachitic sheep grazing green oats, it also occurred in non-rachitic sheep, grazing other winter fodder crops, which had not received additional vitamin D. Growth could be significantly increased by giving a massive dose of vitamin $D_2$. In other words, there appears to be two factors present in green oats (Algerian) grown in New Zealand, one growth-retarding and one rickets-producing, while in green oats (Winter White) grown in England, only the rickets-producing factor is present.

No structural analogue of any of the fat-soluble vitamins has so far been discovered which has anti-vitamin effect in the manner of those synthesized and antagonistic to members of the vitamin B complete[5], or, among biological material, in the way that dicoumarol, found in spoiled sweet clover, is an anti-vitamin K. It seems to me unlikely that we are dealing with an antivitamin of this nature in green oats, for the onset of rickets occurs too suddenly in sheep given this feed for it to be due even to the complex withdrawal of vitamin D activity. Further, there is the fact that calcium absorption is not interfered with and that additional calcium carbonate exacerbates the disease[2].

It appears, then, that we are dealing with a 'toxamin'[6] or 'conditioning factor'[7] in the young oat plant which specifically interferes with the uptake of phosphorus in much the same way as phytic acid, found in high concentration in some cereal grains but not in the young plant, interferes with phosphorus absorption in many monogastric animals, including man.

Feeding experiments, in which rats and mice have also been tested, are now proceeding with various fractions of the green oats, as the next step towards discovering the identity of the rachitogenic factor.

I am indebted to Dr. W. J. Cuthbertson, of Glaxo, Ltd., for the vitamin D assay of the artificially dried green oats.

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June 23.

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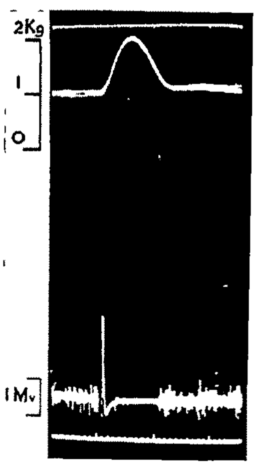
## Significance of the 'Silent Period' of Muscles

THE most attractive theory of the silent period of muscle action potentials is that of Matthews[1,2] (following a speculation of Fulton and Pi-Suñer[3]). In his pioneer work on single nerve endings in muscle, he showed that during a twitch, at a time corresponding to the silent period, there was a pause in sensory discharge from the muscle spindles—the endings believed responsible for exciting postural muscular contractions through the stretch reflex. This cessation of excitatory impulses clearly explained the silent period in the motor discharge. Matthews pointed out that the arrangement of muscle spindles in parallel with the main contractile fibres (which is responsible for the pause during a twitch) formed a self-regulating device, or servo-mechanism, for controlling tonic contraction of the muscle. Increased load or the onset of muscular fatigue would cause elongation of the spindles, thereby reflexly calling up a greater contraction of the muscle tending to restore the system to its original length. The classical type of stretch reflex experiment discloses the static characteristics of the servo; the silent period is its transient response.



Record of the silent period in the human adductor pollicis muscle during a steady voluntary contraction. Top trace: mechanical tension. Bottom trace: action potentials. Time markers 10 msec. and 0.1 sec. Maximal motor stimulus to ulnar nerve delivered 0.1 sec. after start of sweep. Five sweeps superimposed to show the regularity

In recent work on human subjects these ideas have been confirmed and extended. Evidence has been obtained by several independent methods that the duration of the silent period is determined only by the duration of the mechanical twitch of the muscle. For example, using the adductor pollicis, if the muscle is cooled by immersion in cold water, both the twitch and the silent period last longer. Such experiments, which will be described in full elsewhere, demonstrate that the silent period is, indeed, a reflex expression of changes in the afferent inflow from the muscle during its twitch. The records also reveal that in the intact subject the transient response is regular and practically non-oscillatory. In view of the long time lag for nervous conduction round the servo loop (about 35 msec. in the case of the hand muscles), some kind of stabilization must be employed to prevent oscillation: it is conjectured that this is achieved (in a way familiar to the servo engineer) by the use of derivative feedback from the muscle spindles. Matthews showed that the spindles were, in fact, particularly sensitive to rate of change of length, the instance of this property most relevant here being that the pause in discharge during a muscle twitch is briefer than the twitch causing it. For effective stabilization the ratio of derivative to linear feedback required from the spindle depends on the time lag round the loop and the twitch duration. The second conjecture is that this ratio (which will be different in different muscles and under different conditions of temperature and fatigue) is adjustable by means of the motor nerve supply to the intrafusal muscle fibres of the spindle. Here again Matthews provides evidence that the response of the spindle is altered by contraction of the intrafusal fibres.

This theory cannot be regarded as in any way established by the available facts, but its implications are wide and suggestive of new experiment; it introduces a new degree of freedom into the stretch reflex; not only is the gain round the loop (reflex briskness) to be considered, but in addition the type of feedback can vary under the influence of motor discharge to the intrafusal muscle bundle with decisive influence on the characteristics of the servo For example, the symptoms of spasticity might be due not, as Hughlings Jackson thought, to overactivity of the spinal cord consequent on its release from higher control, but to mere lack of control over the response of the muscle spindles—a notion which emphasizes our almost complete ignorance of the central connexions of the motor nerve fibres going to the spindles, although in number they are a large proportion of the total[4]

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June 14

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## Effect of Indole and some Indolic Compounds on Muscle Sensitivity to Acetylcholine and Potassium

AMONG the indolic compounds formed from tryptophane in animal intestine, indole, skatole and indolethylamine are those reported to have the strongest pharmacological action Their effect on plain or striated muscle has been studied in the past, either *in vivo* or in the isolated organs, although with no clear and consistent results[1–5] More recently, Torda and Wolff[6] have examined the effect of indole, skatole, indole-3-acetate and tryptophane on the sensitivity of frog striated muscle to acetylcholine and potassium, finding that only indole increases the response to acetylcholine, while indole, skatole and indoleacetate increase the potassium effect Since the presence in the bowel of indole and allied compounds seems to be a normal fact[7], and that the intestinal membrane can absorb and fix significant amounts of indole[8], and presumably other indole compounds as well, it seemed interesting to study their effect on the intestinal smooth muscle, as it might have implications in regard to the alterations of intestine motility.

| Stimulant | Inhibitor | Per cent diminution of shortening |
|---|---|---|
| 1 1 μgm AcChol | 2 0 × $10^{-4}$ *M* indole | 17 2 ± 1 4* |
| 3 0 mgm KCl | 1 2 × $10^{-4}$ *M* ,, | 7 4 ± 1 1 |
| 1 2 μgm AcChol | 1 1 × $10^{-4}$ *M* skatole | 54 4 ± 2 6 |
| 3 0 mgm KCl | 1 1 × $10^{-4}$ *M* ,, | 53 0 ± 3 9 |
| 3 0 mgm KCl | 1 5 × $10^{-4}$ *M* indole | 10 4 ± 1 8 |
| 3 0 ,, ,, | 4 2 × $10^{-5}$ skatole | 15 0 ± 0 3 |
| 3 0 ,, ,, | Indole plus skatole | 30 0 ± 1 4 |
| 5 0 μmgm AcChol | 1 8 × $10^{-4}$ *M* indole | 12 8 ± 2 9 |
| 5 0 ,, ,, | 2 7 × $10^{-5}$ *M* skatole | 13 8 ± 2 9 |
| 5 0 ,, ,, | Indole plus skatole | 31 4 ± 2 0 |

* Probable error (see ref 9)

Diminution (average of three to five experiments) produced by the inhibitor on the shortening of the muscle induced by acetylcholine (AcChol ) or potassium (KCl) Contractions in the presence of the inhibitor have been considered only when intercalated between two control contractions of the same height Terminal portion of guinea pig ileum immersed in 18–22 ml Tyrode solution, saturated with oxygen containing 5 per cent carbon dioxide at 38° The amount of the muscle contraction was registered on a kymograph by an isotonic lever and measured

With a technique similar to that employed by Torda and Wolff[6], we have studied the effect of indole, skatole, potassium indoxylsulphate, indoleacetate, indolethylamine, indolepropionate and L-tryptophane on the sensitivity to potassium and acetylcholine of the terminal portion of the guinea pig ileum and, for comparison, the frog (*Leptodactylus ocellatus* (L ) Gir ) anterior rectus abdominis When using the striated muscle we have been able to confirm Torda and Wolff's results, but with the smooth muscle the effect of the indolic compounds was completely different As it is shown in the accompanying table, which reproduces typical experiments, relatively small concentrations of skatole and indole, which *per se* do not affect significantly the tonus or contractility of the intestine, diminished the shortening induced by potassium or acetylcholine The inhibition was reversible, and required for its full development about 5–10 min incubation of the intestine with the inhibitor The $pI_{50}$ ($-\log_{10}$ molarity producing 50 per cent inhibition) of indole and skatole were 3 3 and 4 0 respectively, with acetylcholine as stimulant The relaxation of the intestine when contracted by acetylcholine alone was also affected by indole and skatole, proceeding in the presence of the inhibitors at a slower rate, and in some experiments the muscle remained in the contracted state When acting together, indole and skatole added their effects either on contraction or relaxation Indolethylamine slightly increased the effect of acetylcholine on smooth muscle, while indoxylsulphate increased the effect of potassium on the striated muscle Indoleacetate, indolepropionate and L-tryptophane did not modify the effect of potassium or acetylcholine on the guinea pig ileum when tested in concentrations near or higher than those used for indole and skatole

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## Physiological Action of the Toxin of the Egyptian Scorpion

THE main physiological effects produced by the toxin of the Egyptian scorpion[1] are (1) inhibition of rabbit smooth muscle , (2) acceleration of the isolated rabbit and frog heart (antagonized by ergotoxin) , (3) rise of blood pressure of the dog (reversed by ergotoxin) , (4) vomiting, and contraction of intestine and bladder of rabbit and dog in the intact animal (antagonized by atropine)

In considering whether the toxin acts as a stimulator of sympathetic nerve endings, a study has been made of the effect of the toxin on the blood-sugar levels of normal and immune animals Using the method of Hagedorn and Jensen, it was found that

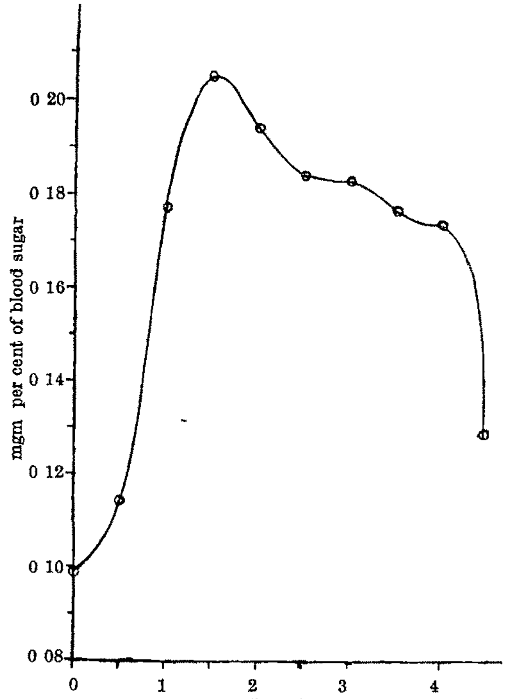

Fig 1. Blood-sugar curve for rabbit

a blood-sugar level of 1 02 mgm /ml increased to 1 39 mgm /ml thirty minutes after the injection of 1 mgm of toxin, and to 2 59 mgm /ml one hour after injection The injection of a sublethal dose of toxin into fasting rabbits was followed by a considerable rise, which reached a maximum an hour after injection, and was maintained for a time which varied usually with the dose of toxin injected Fig 1 is a typical blood-sugar curve of a 2-kgm rabbit, fasted for 12 hours, and then injected with 1 mgm toxin subcutaneously

In some experiments with dogs, No 1 (13 84 kgm ) had 0 0625 gm per cent of sugar in the blood, after injection with 0 346 gm of toxin, this had increased to 0 085 gm per cent 90 min later, and to 0 107 gm per cent in two hours The injection of sublethal doses of toxin into fasting non-immunized dogs was always followed by an increase which attained a maximum in about two hours, this high level was maintained for a time which varied usually with the dose of toxin injected Fig 2 is a typical blood-sugar curve of a dog (No 2, 14 48 kgm ) injected subcutaneously with 0 241 gm toxin (after being starved for 12 hours)

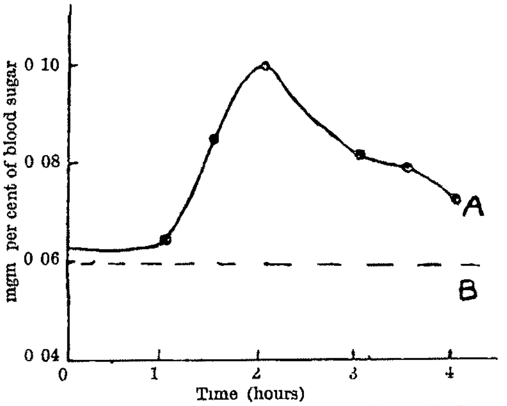

Fig 2 Blood-sugar curve for dog (*A*) before, (*B*) after immunization

When a lethal dose of toxin was injected into fasting, immunized dogs[2], no increase whatever in the blood-sugar level occurred, and this remained unaltered for at least five hours Moreover, when a lethal dose of toxin, previously neutralized with antitoxin and the mixture incubated for 1 hour at 37°, was injected into fasting, non-immunized dogs of the same weight, the blood-sugar level remained unaffected

The experiments demonstrated, therefore, that the subcutaneous injection of sublethal doses of scorpion toxin into rabbits and dogs causes hyperglycæmia; and that this effect ceases to be shown as immunity is developed

My thanks are due to Prof A Hassan for his help in this work

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## Determination of Rate of Secretion of Thyroxine in the Male Rabbit

BROADLY speaking, the rate of secretion of thyroxine is the amount of thyroxine secreted into the general circulation by the thyroid gland in a given period of time under specified conditions The secretory activity of the thyroid is generally regarded as being governed by an interaction and balance between the thyroid hormone and the anterior pituitary thyrotrophin

In the present investigation, the rate of secretion of thyroxine of the growing male rabbit (thyroxine and thiouracil injected simultaneously for a period of two weeks), at 4, 8, 16, 32 and 48 weeks of age, was estimated by a technique in which varying levels of L-thyroxine were injected daily subcutaneously into the animals with the simultaneous administration of 0 1 per cent thiouracil as part of the ration for a period of four weeks The administration of thiouracil prevented the synthesis of thyroxine by the thyroid gland, the resultant lowered thyroxine level in the blood stimulated the secretion of thyrotrophin, which in turn caused thyroid enlargement By injecting graded dosages of L-thyroxine, the weight of the thyroid was reduced in the thiouracil-treated rabbits and the reduction in general was proportional to the thyroxine dosage Thus the establishment of a normal thyroxine–thyrotrophin equilibrium by injection of thyroxine in the thiouracil-treated animal resulted in a thyroid weight equal to that of the control The quantity of thyroxine required to bring about this result was considered to be an estimate of the normal rate of secretion of thyroxine by the thyroid

It was observed that the rate of secretion of thyroid increased with advancing age in the male rabbit, and the estimated rates of secretion of L-thyroxine in a 4- and 48-week old male rabbit were 8 4 and 21 9 μgm /day respectively However, when calculated per 100 gm body-weight, the rate decreased with advancing age The relation of the thyroid secretion-rate to body-weight can be expressed by the equation

$y = 0\;43x^{0\;48}$, where $y$ is the amount in micrograms of L-thyroxine secreted per day and $x$ is the body-weight in grams

A decrease of about 23 per cent in the daily rate of secretion of thyroid of 16-week old male rabbits was observed during the summer months when compared with that estimated during the winter This decrease in the rate of thyroid secretion may be due to differences in the environmental temperature Castration of the male rabbit at the age of 8 weeks resulted in a decrease of about 30 per cent in the rate of secretion of thyroxine after a period of 24 weeks, when compared with the control, but no effect was observed on the weight of the thyroid after a period of 4 weeks This shows that age is an important factor in augmenting the effect of castration on the rate of secretion of thyroxine of the male rabbit The results of the present experiments will be described fully elsewhere

I wish to thank Dr J Hammond and Dr Arthur Walton for their interest and for providing facilities in their laboratories

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## Mechanism of Epinephrine-induced Tachycardia in the Frog

Although epinephrine was the first hormone isolated, knowledge of its mechanism of action has remained negligible One method of attacking the problem of its mode of action is through a study of antagonists, this method has now provided somewhat unexpected information on the subject

Adrenergic blocking agents, in general, fail to antagonize the chronotropic and inotropic responses of the mammalian heart to epinephrine, but results with the frog heart have been highly variable[1] Studies on isolated, perfused hearts of *Rana pipiens* in our laboratory during January 1949 indicated that 'Dibenamine' and a number of its active congeners (β-haloalkylamines), and several ergot alkaloids are all capable of blocking the chronotropic response to epinephrine The inotropic response is unaffected Attempts to extend these results during February and March produced conflicting results and by the end of March the 'Dibenamine'-type blocking agents were completely ineffective and the ergot alkaloids were only about 10 per cent as effective as previously Further studies on this seasonal variation demonstrated that resistance develops rapidly in late February and March and that sensitivity returns to a maximum during August

The observed seasonal changes in sensitivity do not correlate well with seasonal temperature variations However, temperature may be a factor in determining sensitivity Cooling resistant animals to 4–8° C for two to four weeks markedly increases the sensitivity of the heart to blockade, but cooling for only a few days is ineffective The anterior pituitary gland proved to be the key to these changes Small amounts of hog whole- or anterior-pituitary extract injected into the intact frog induce, within 12–24 hr, complete resistance to blockade by the β-haloalkylamines

The chronotropic response of the heart is an expression of an increased energy metabolism On the assumption that the resistance of the summer-frog heart might be due to the presence of some metabolic pathway by-passing the point of inhibition by the adrenergic blocking agents, an attempt was made to block its response by combining a β-haloalkylamine adrenergic blocking agent with various known metabolic inhibitors Monofluoroacetate ($3 \times 10^{-7}$ $M$) and iodoacetate ($1 \times 10^{-5}$ $M$) combined with a β-haloalkylamine produced a blockade of the summer-frog heart comparable to that produced by the β-haloalkylamine alone in the winter-frog heart Cyanide, azide, cadmium, arsenate, arsenite, fluoride, α,α-dipyridyl,3,4-dinitrophenol, malonate, pyrophosphate and iodoacetamide were completely ineffective None of these inhibitors antagonized the chronotropic response to epinephrine when tested alone, and none altered the inotropic response, either alone or in combination.

The blocking activity of fluoroacetate and particularly that of iodoacetate, although iodoacetamide was completely inactive, suggested that acetate metabolism was involved in the chronotropic response of the frog heart to epinephrine Glycerolmonoacetate effectively antagonizes the lethal action of fluoroacetate in mammals[2] Consequently, the effect of this agent on the blockade of the chronotropic response produced by the adrenergic blocking agents, with and without added fluoroacetate, was studied Glycerolmonoacetate ($4 \times 10^{-6}$ $M$) eliminates the blockade in a non-competitive manner, behaving always as a 'product' of the reactions blocked Sodium acetate and glycerol are ineffective Glycerolmonoacetate does not itself alter the inotropic response to epinephrine or the rate or strength of contraction in the absence of epinephrine These results indicate that although the adrenergic blocking agents and fluoroacetate affect different metabolic pathways, they inhibit a similar step in metabolism

Quantitative studies of the blockade were also carried out The relationship between epinephrine and fluoroacetate or one of the adrenergic blocking agents is competitive, indicating common sites of action

On the basis of the above results it may be concluded that the chronotropic response of the frog heart to epinephrine is dependent upon two distinct effects of the activating agent (1) a stimulation of the production of 'utilizable acetate', and (2) a 'trigger action' which is effective only in the presence of a suitable 'acetyl' substrate The epinephrine-stimulated production of 'utilizable acetate' may proceed by two distinct pathways a 'stable' path-

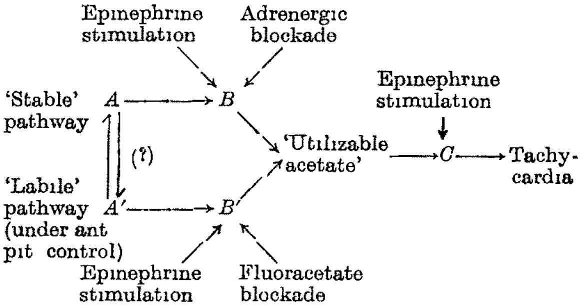

Diagram of possible points of action of epinephrine and certain blocking agents on the processes leading to the production of an epinephrine-induced tachycardia *A* and *A′* represent metabolic substrates in the myocardium which may or may not be independent of each other *B* and *B′* are parallel reactions affected by epinephrine and blocking agents *C* depicts the final point of action of epinephrine in initiating the tachycardia way which appears to be qualitatively and quantitatively constant throughout the year and which is blocked by β-haloalkylamine and ergot alkaloid adrenergic blocking agents, and a 'labile' pathway which normally functions only in the summer-frog heart, and which is activated by the anterior pituitary gland and is blocked by fluoroacetate and iodoacetate Both these pathways appear to be completely independent of the energy sources utilized in the normal contraction of the heart and in its positive inotropic response to epinephrine Epinephrine thus appears to promote the production of the metabolic substrate required for the expression of its own chronotropic action

A full report of these studies will be submitted for publication in the *American Journal of Physiology*

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## Gonadotrophin from the Neural Region of Ascidians

POSTERIOR pituitary hormone analogues have been known from the neural region of Ascidians for some time[1,2], though doubt has been thrown on their reality[3] One investigator only seems to have looked for anterior pituitary hormones[4] , he examined an extract from the neural region (ganglion + neural gland + ciliated pit) of *Polycarpa* for gonadotrophically active substance Unfortunately, as he admitted himself, he had not sufficient material for an adequate test, so his results remained inconclusive and have not been generally accepted In the course of other investigations I have had occasion to repeat this work using two other Ascidians, *Ciona intestinalis* (L ) and *Phallusia mammilata* (Cuv )

The neural glands were ground with sand in acetone and hydrochloric acid to *p*H *c* 1 0 in such volume that the final liquid contained 15 per cent water The debris was filtered off and enough acetone added to the filtrate to reduce the water content to 4–6 per cent A precipitate was formed which was filtered off, washed with a little acetone and dissolved in distilled water + sodium hydroxide to *p*H 8 0 This treatment when applied to mammalian anterior pituitaries yields an extract containing almost all the hormonal material present No attempt was made to purify the material further

*Exp* 1. The extract from 230 specimens of *Phallusia* was injected into three female mice aged 26 days, so that each received six injections of 0 5 ml. within 48 hr. Each mouse received 3 0 ml , representing the extract derived from 75 specimens of *Phallusia* The controls—unfortunately only two, since one died during the experiment—received injections of an extract prepared from the same weight of other body tissues of *Phallusia* by the same method The mice were sacrificed 96 hr from the start of the experiment The ovaries were weighed in pairs, fixed in corrosive-formal, and stained, after sectioning, in Ehrlich's hæmatoxylin The ova above a certain arbitrary limit of size (1 division of an uncalibrated eyepiece micrometer) were counted in each ovary in sections at every 80 μ The weights of the pairs of ovaries in the experimental animals were 13, 14 and 9 mgm (average 12 mgm ) , in the controls, 2½ and 6 mgm (average 4½ mgm ) The number of large ova in the experimental animals was 71, 93, 101, 82, 77, 64 (average 81 2) , in controls, 40, 23, 37, 30 (average 32 5) In the experimental animals, the beginnings of follicular maturation were apparent in spaces appearing between the cells , and the largest follicles were visible to the naked eye in the fresh dissection In the ovaries of the controls, there were no such spaces, and the ovaries appeared quite smooth Fallopian tubes were developed further in experimental animals than in the controls

*Exp* 2 The extract derived from 120 *Ciona* was injected into the dorsal lymph-sac of three male toads in a single dose each The same individuals were afterwards used as controls, receiving injections of an extract of other body tissues of *Ciona* The positive response to this test is the appearance of sperm in the cloacal fluid The results may be summarized thus

| | | | | | |
|---|---|---|---|---|---|
| 0 hr | All – | Injection | 72 hr | All – | Control injection |
| 6 hr | All – | | 78 hr | All – | |
| 9 hr | 1 +, 2 – | | 81 hr | All – | |
| 20 hr | 2 +, 1 – | | 92 hr | All – | |

An extract of the neural region of *Ciona* has caused sperm release in two out of three toads when injected in a dose equivalent to 40 specimens into each toad. An extract of the rest of the body of *Ciona* produced no such response

We may conclude that a gonadotrophically active substance can be extracted from the complex 'ganglion–neural gland–ciliated pit' of *Ciona* and *Phallusia*, and presumably of Ascidians in general, but not from the rest of the body Hogg's conclusions are confirmed As a further confirmation that a gonadotrophin may play some part in the natural biology of the Ascidian, I may add that I have observed that an injection of chorionic gonadotrophin into *Phallusia* or *Ciona* stimulates ovulation

This work was carried out in the Zoological Station of Naples while holding the Oxford Naples scholarship, a senior demyship of Magdalen College, Oxford, and a Beit Memorial fellowship for medical research

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## Acute Action of Goitrogenous Agents on the Body Temperature and Oxygen Consumption of the Rat

IT has been demonstrated with rats that a single subcutaneous injection of aminothiazole (0 01–0 02 gm ), methylthiouracil (0 03–0 07 gm ) or methylsulphathiazole (0 03–0 05 gm ) is followed by a fall in body temperature and, after an occasional initial rise, by a marked decline in oxygen consumption These effects are even more marked in the thyroid-

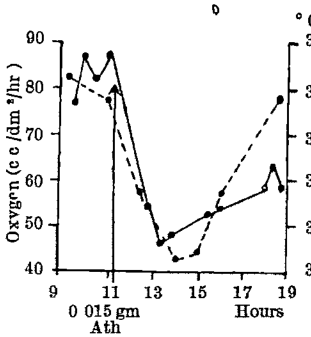

Fig 1

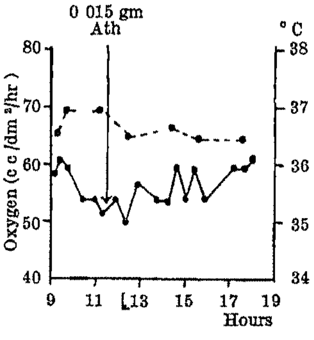

Fig 2

Fig 1 Rat 254 190 gm , male Operation January 13, 1950 Electrodes introduced into hypothalamus, but no current was passed Aminothiazole experiment performed on January 28, 1950

Fig 2 Rat 256 110 gm , male Thyroidectomy, January 13, 1950 Bilateral lesion of hypothalamus, January 15, 1950 Aminothiazole experiment performed on February 4, 1950

●- - -●, body temperature
●——●, oxygen consumption

ectomized or hypophysectomized animal[1,2] During the fully developed action of aminothiazole, a decrease of environmental temperature from 29° to 21° C fails to evoke a rise in oxygen consumption in the rat The action of α-dinitrophenol on oxygen consumption is not impaired by aminothiazole Section of the thoracic cord has no effect on the acute action of aminothiazole on body temperature and oxygen consumption , but, after section of the cervical cord, aminothiazole has no effect on body temperature and causes a transitory rise, instead of a fall, in oxygen consumption[3]

These observations suggested that the acute action of goitrogenous agents on oxygen consumption may be of central nervous origin Therefore, using the Horsley-Clarke stereotactic instrument, bilateral electrolytic lesions were made in the hypothalamus of the rat Fig 1 demonstrates a normal response to aminothiazole in a sham-operated animal (no current passed through the electrodes), and Fig 2 shows the typical absence of a response in an animal with bilateral lesions in the posterior part of the hypothalamus

All animals in which the hypothalamic lesion was associated with a marked disturbance of thermo-regulation failed to respond to aminothiazole In a few instances, in animals in which the disturbance of thermo-regulation was not gross, an isolated effect on body temperature or oxygen consumption was observed It would appear, therefore, (1) that the acute action of aminothiazole on oxygen consumption involves a central nervous mechanism in which the hypothalamus plays an essential part, and (2) that the effects on body temperature and oxygen consumption are not strictly linked, as these may be abolished either independently or together by lesions not severely impairing thermo-regulation

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## Hydroxytyramine in Mammalian Heart

Extracts of mammalian hearts have been shown to contain adrenaline[1,2] and *nor*adrenaline[3,4] Hitherto there has been no indication of other catechol substances in mammalian heart However, hydroxytyramine occurs in urine[5,6], and has recently been found in sheep suprarenals[7]

When extracts of sheep hearts were concentrated and subjected to paper chromatography, three catechol spots were observed As to colour and position, they were comparable to known solutions of adrenaline, *nor*adrenaline and hydroxytyramine This identity was substantiated by exposing the extract chromatogram to two different solvent systems, namely, *n*-butanol / *N* hydrochloric acid[8] and phenol/water[9]

In addition, this extract was run through a starch column with *n*-butanol/*N* hydrochloric acid as solvent, for identification by fractionation[8] The column was run for approximately eighty hours with each fraction representing one hour The *R*-values are given in the accompanying table The *R*-values obtained with sheep heart extract correspond to the results obtained from pure solutions of hydroxytyramine, adrenaline and *nor*adrenaline run over an equivalent period

*R*-Values obtained by Chromatographic Separation of Adrenaline *Nor*adrenaline and Hydroxytyramine on Starch using *n*-Butanol/*N* Hydrochloric Acid as a Solvent

| Exp | Amounts of added substances | *R*-values | | |
|---|---|---|---|---|
| | | Hydroxy-tyramine | Adrena-line | *Nor*-adrenaline |
| 1 | 2,080 μgm hydroxytyramine + 620 μgm adr-HCl + 640 μgm DL-*nor*adr-HCl | 0 328 | 0 247 | 0 155 |
| 2 | 505 μgm hydroxytyramine+430 μgm adr-HCl + 610 μgm DL-*nor*adr-HCl | 0 313 | 0 222 | 0 136 |
| 3 | Sheep heart extract* | 0 347 | 0 236 | 0 146 |

* The extract was prepared for the column by distillation with *n*-butanol[8]

Each group of these fractions was tested biologically, colorimetrically and chromatographically, and in all cases was comparable to known solutions of hydroxytyramine, adrenaline and *nor*adrenaline

The presence of hydroxytyramine in normal sheep heart is suggestive of the role that hydroxytyramine may have as a precursor of *nor*adrenaline[5,10]

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## Phenol Oxidases of the Cultivated Mushroom *Psalliota bispora f. albida*

THE mycelia of certain wood-rotting and litter-decomposing Hymenomycetes form enzymes of the laccase type[1]. I have shown that the mycelium of *Marasmius graminum* produces a copper-containing phenol oxidase of the same type. This enzyme catalyses the oxidation of polyphenols and aromatic diamines, the oxidation of *p*-phenylenediamine being much faster than that of catechol. It is not poisoned by carbon monoxide[2]. The fruit-bodies of the cultivated mushroom, *Psalliota bispora f. albida* (= "*Ps. campestris*"), contain a polyphenol oxidase which oxidizes catechol but not *p*-phenylenediamine and which is inhibited by carbon monoxide[3]. Provided that the mycelium of *Ps. bispora* contains the same carbon monoxide-sensitive oxidase, it should be possible to clarify the problem of whether the phenol oxidases of these fungi act as terminal respiratory enzymes. This might be done by studying the influence of carbon monoxide on the respiration of the mycelia. The respiration of the *Psalliota* mycelium ought to be sensitive to carbon monoxide whereas that of *Marasmius* ought to be insensitive. Therefore, the mycelia of both fungi were grown in Barcroft vessels, and the influence of carbon monoxide on the respiration was determined. Respiration was not inhibited in either of the two fungi.

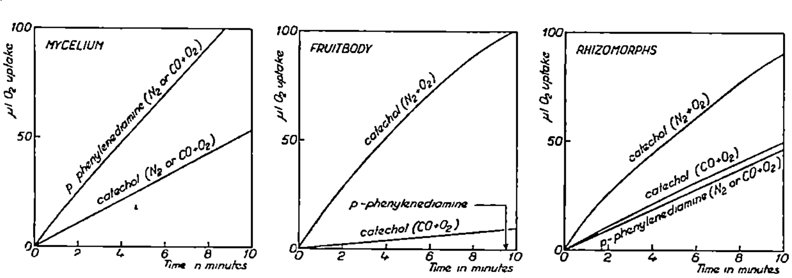

Fig. 1 Fig. 2 Fig. 3

Effect of carbon monoxide on the oxidation of catechol and *p*-phenylenediamine by enzyme extracts from mycelium, fruit-body, and rhizomorphs of *Psalliota bispora f. albida*

The phenol oxidase of the *Psalliota* mycelium was investigated further. The mycelium was grown on the following nutrient solution: glucose, 10 gm.; asparagine, 1 gm.; $MgSO_4 . 7H_2O$, 0.5 gm.; $KH_2PO_4$, 0.45 gm.; $Na_2HPO_4$, 0.47 gm.; Ca, 20 p.p.m.; Mn, 2.7 p.p.m.; Fe, Zn and Cu, 1 p.p.m.; aneurin, 50 μgm.; yeast extract, 100 mgm.; distilled water to 1,000 ml. (cf. Treschow[4]). After five weeks, the mycelium was collected from the flasks, washed and ground with sand after addition of $M/10$ phosphate buffer, *p*H 6.8. The extract was centrifuged and filtered. The filtrate was saturated with ammonium sulphate, and the precipitate was collected by centrifuging at high speed, dissolved in a small quantity of water and dialysed.

When cultivated in composts, *Ps. bispora* forms rhizomorphs, that is, strings of hyphæ which transport substances from the absorbing mycelium to the fruit-bodies. Extracts from rhizomorphs and from fruit-bodies were prepared in the same way as from the mycelium.

The ability of the three enzyme extracts to catalyse the oxidation of catechol and *p*-phenylenediamine and the influence of carbon monoxide on these oxidations were studied in Barcroft manometers. Experiments were run in 90 per cent nitrogen + 10 per cent oxygen and in 90 per cent carbon monoxide + 10 per cent oxygen. The following system was used: 5 mgm. catechol or *p*-phenylenediamine, a suitable amount of enzyme extract, $M/10$ phosphate buffer *p*H 6.8 to a final volume of 3.3 ml. (see graphs).

The mycelium extract catalysed the oxidation of *p*-phenylenediamine and catechol, the oxidation of the diamine being about twice as fast as that of catechol. The enzyme was not influenced by carbon monoxide. Thus, the mycelium contains an enzyme of the laccase type.

The extract from the fruit-body oxidized catechol but not *p*-phenylenediamine. It was strongly inhibited by carbon monoxide.

From the rhizomorphs, finally, an extract was obtained which, like that of the mycelium, catalysed the oxidation of *p*-phenylenediamine and catechol. However, the oxidation of the catechol was faster than that of the diamine. Furthermore, the oxidation of the catechol was partly inhibited by carbon monoxide, whereas the oxidation of *p*-phenylenediamine was not influenced by this gas. These results may be interpreted as follows. The oxidation of the *p*-phenylenediamine was due to laccase, which is not influenced by carbon monoxide. The oxidation of the catechol was partly due to the same laccase and partly to polyphenol oxidase, which is sensitive to carbon monoxide and which is of the same type as that occurring in the fruit-bodies.

Thus, with *Ps. bispora f. albida* the mycelium produces laccase and the fruit-bodies produce a carbon monoxide-sensitive polyphenol oxidase, whereas in the rhizomorphs a mixture of both enzymes is formed.

I am indebted to Prof. D. Keilin and Dr. T. Mann for their help and advice. This work was supported by a grant from the Swedish Natural Science Research Council.

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## High Toxicity of Pure Botulinum Type *D* Toxin

CULTURES of *Clostridium botulinum* Type *D* were grown in intussuscepted 'Cellophane' tubes[1-3]. Ammonium sulphate to 40 per cent saturation was added to the filtered dialysed culture and the *p*H adjusted to 5.8. The slight precipitate which formed immediately after the solution of the ammonium sulphate was found to contain most of the toxin, and was re-dissolved and precipitated at between 25 and 30 per cent saturation at *p*H 5.8. Subsequent precipitations were carried out at between 25 and 30 per cent saturation with ammonium sulphate, depending on the results of toxicity tests and nitrogen determinations. Purification was continued until the toxin was electrophoretically homogeneous. Diffusion measurements, however, showed that the material was polydisperse, and that the major part diffused at a rate consistent with an average molecular weight of about a million.

The toxicity was measured by injecting appropriate dilutions of the botulinum Type *D* toxin into 20-gm white mice, eight mice, as a rule, being used for each dilution There was little difference between the results of subcutaneous or intraperitoneal injection When the toxin was diluted in 0 2 per cent gelatin in phosphate buffer at *p*H 6 2, the very high toxicity of $4 \times 10^{12}$ m l d /mgm protein nitrogen was obtained The gelatin – phosphate diluent was very similar to that used by Lamanna *et al* [4] and Abrams *et al* [5] in establishing the titre of pure botulinum Type *A* toxin

This diluent, as well as others tried, appeared to have a 'potentiating' action on the toxin similar to that described by Traub *et al* [6] One of us (M S ) has suggested that this might be due to a disaggregation of the toxin into smaller active units Svedberg and Pedersen[7], as well as a number of other workers, have discussed the dissociation of proteins under the influence of other proteins, amino-acids and simple inorganic ions

Lamanna *et al* [4] and Abrams *et al* [5] found that pure botulinum Type *A* toxin diluted in gelatin – phosphate had a toxicity for mice of $220 \times 10^{6}$ m l d /mgm protein nitrogen Botulinum Type *D* toxin, under similar conditions, appeared to be up to 20,000 times as toxic for the mouse as pure Type *A* toxin

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## A Unit of Penicillinase

THE presence of the enzyme penicillinase in extracts of *B coli* and other micro-organisms was first described by Abraham and Chain[1] Later, a unit of penicillinase potency was proposed by McQuarrie, Liebmann, Kluener and Venosa[2] Since that time several groups of investigators have studied this enzyme[3-11] and defined their own relative units of activity This was justified by the fact that no pure crystalline product suitable as a reference standard was available The definitions of these units are all based on arbitrary experimental conditions of inactivation and techniques of penicillin assay, and thus do not permit interconversion Moreover, the majority of the techniques used are based on penicillin inactivation at the lower ranges of concentrations at which the rate of destruction is a function of both the penicillinase concentration and the penicillin concentration, while the latter is decreasing during the experiment

It has been our endeavour to determine the conditions under which the analysis of penicillinase activity can be made independent of the technique employed in determining the amount of penicillin inactivated On this basis a definition of a unit of potency is proposed which is similar in magnitude to the original unit of McQuarrie *et al* [2]

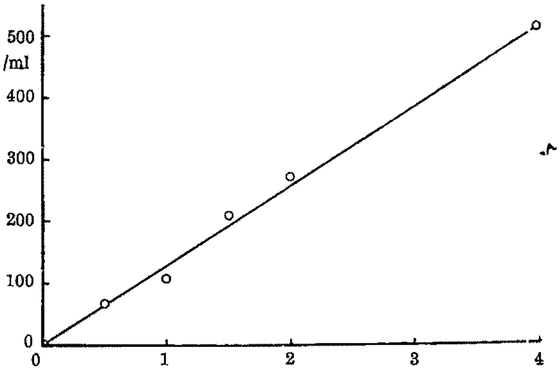

Fig 1 Inactivation of penicillin

To achieve this the following conditions were found essential · (1) inactivation of penicillin should be negligible in the absence of the enzyme , (2) rate of inactivation should be proportional to the enzyme concentration , (3) rate of inactivation should be independent of the concentration of penicillin.

This last stipulation is fulfilled over a wide range of penicillin concentration Wise and Twigg[11] found this to be the case at about 200 u /ml , Henry and Housewright[7] around 1,000 u /ml , and we tested the hydrolysis at concentrations up to 60,000 u /ml and found the reaction-rate to be independent of the penicillin concentration Under these conditions the second requirement is also fulfilled, namely, the reaction-rate is inversely proportional to the dilution of the enzyme preparation within the practical range of operation, requiring a few minutes to a few hours for the bulk of the penicillin present to be inactivated To satisfy the first requirement it is necessary to conduct the reaction at a *p*H not exceeding 7 0 and at room temperature, even though these conditions do not represent exact maxima of penicillinase activity Additional points of importance for a definition which is free of ambiguity is the nature of the buffer and the absence of chance impurities in the substrate[7,11] Furthermore, the nature of the penicillin salt may also have some influence[7]

When all these conditions are properly considered, the observation of the penicillinase activity is truly independent of the testing technique The manometric method[7] or the alkalimetric method[11] cited may be suitable In addition we developed three unrelated methods, a polarimetric and an iodometric titration method, both of which we intend to describe in detail elsewhere, and a microbiological method which is used in the following as an illustration

A solution of potassium benzylpenicillin (purity 1,530 u /mg ) in 0 1 *M* phosphate buffer at *p*H 7 0 was prepared containing about 3,500 u /ml 1-ml

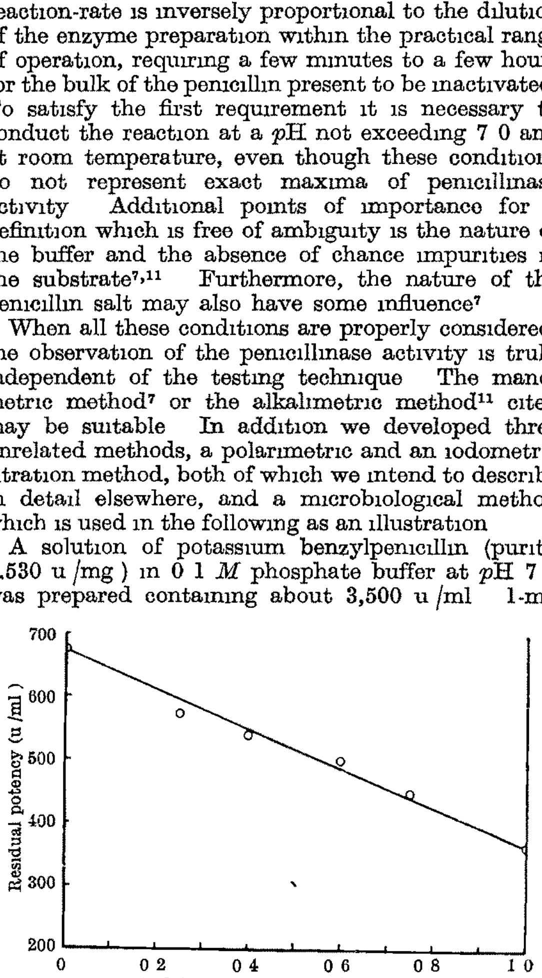

Fig 2 Dependence of penicillin destruction on enzyme concentration

portions of a penicillinase stock solution prepared with 0 1 *M* phosphate buffer were added to 20-ml aliquots of this solution After a predetermined time the penicillin remaining was extracted as follows The sample was rapidly acidified with phosphoric acid (50 vol per cent) to *p*H 2 3 using a glass-electrode *p*H meter and immediately extracted with two 20-ml portions of ice-cold amyl acetate The combined amyl acetate portions were re-extracted with two portions of 40 ml of 0 2 *M* phosphate buffer at *p*H 7 0 and made up to 100 ml Controls, to which the penicillinase was added immediately before extraction, were also prepared and all extracts were assayed for penicillin by a turbidimetric, *S aureus*, microbiological assay method The assay values were subtracted from the values found in the controls (the controls showed a loss of only about 1 5 per cent of activity per hour) These are the values which are plotted in Fig 1 The independence of the reaction-rate of the penicillin concentration, that is, a typical zero-order reaction-rate, is obvious The validity of these data depends on the completeness of the extraction procedure, which was tested previously[11], and the precision of the assay, which is of the order of ± 5 per cent

As mentioned before, under the conditions described, the rate of inactivation is proportional to the enzyme concentration This is illustrated by the following experiment To a stock solution, prepared as the one described above, aliquots of a penicillinase solution were added After exactly one hour these samples were extracted as described The potencies found are plotted (together with that of the original solution) in Fig 2, showing the proportionality of the inactivation to the enzyme concentration

Essentially identical results were obtained with both the polarimetric and the iodometric procedure, and similar results by the two other techniques cited[7,11] Hence the validity of our postulates seems established

Therefore our definition is

A unit of penicillinase effects the inactivation of $10^{-7}$ moles of penicillin (35 6 mcg or 59 3 units of sodium benzylpenicillin) per hour at 25° C at *p*H 7 0 This action takes place in a phosphate buffered solution of a pure alkali salt of benzylpenicillin in sufficient concentration to maintain a zero-order reaction-rate

The technical assistance of members of these Laboratories, particularly that of Mr David Fergus, is gratefully acknowledged Thanks are expressed to Dr B Puetzer and Dr K Ladenburg for encouragement and to Schenley Laboratories, Inc , for permission to publish this communication

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Schenley Laboratories, Inc ,
Lawrenceburg, Indiana July 7

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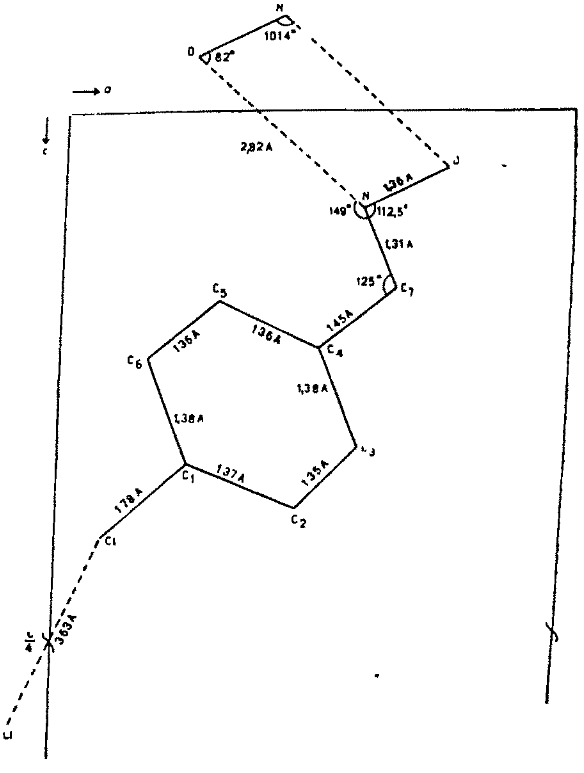
## Crystal Structure of *syn p*-Chlorobenzaldoxime

As a first step in the survey of several oxime structures, the crystal structure of *syn p*-chlorobenzaldoxime has been examined by X-ray analysis So far, no detailed crystallographic data on an oxime have been published , the results now obtained are interesting on account both of oxime stereochemistry and of the actual inter-atomic distances present, both intra- and inter-molecular

*syn p*-Chlorobenzaldoxime was prepared by the method of Erdmann and Schwechten[1], after recrystallization from alcohol or benzene, the melting point was 109½–110½° (110° litt ) The crystals are monoclinic needles, elongated along the *b* axis The space-group is $P2_1/c$, $a = 6\ 06$ A , $b = 4\ 73$ A , $c = 25\ 0_6$ A , $\beta = 93\ 4°$ (copper $K_{\alpha_1} = 1\ 5405$ A ), $n = 4$ The intensities of the X-ray reflexions were estimated visually from Weissenberg photographs, the multiple-film technique being used The crystal structure was established by the calculation of Patterson projections, *Puw* and *Pvw*, followed by successive refinements of the corresponding electron density projections, $\rho xz$ and $\rho yz$ From these, which were both well-resolved projections, the co-ordinates of all the atoms in three dimensions could be assigned Based on these co-ordinates, the discrepancy between observed and calculated structure factors, $\Sigma\big||F_{\text{obs}}| - |F_{\text{calc}}|\big| / \Sigma |F_{\text{obs}}|$ was 21 7 per cent and 18 4 per cent for the reflexions $(h0l)$ and $(0kl)$ respectively, non-observed reflexions included

The atomic arrangement found is illustrated in the accompanying diagram, which shows part of the crystal structure viewed along the *b* axis , inter-atomic distances are given in this diagram, as well as the magnitude of some bond angles It is possible



that these will be changed a little when the three-dimensional electron density distribution is calculated. However, exactly the same C—N distance, 1.31 A., and N—O distance, 1.36 A., have recently been found in acetoxime by Bierlein and Lingafelter[2]. So far, no other comparable C—N distance has been observed; the N—O distance, as might be expected, is appreciably shorter than the corresponding distance in hydroxylamine hydrochloride which was found[3] to be 1.45 A.

The chlorine atom and all the carbon atoms of the aldoxime molecule are situated very nearly in a plane, the deviations from an approximating plane being ± 0.03 A. or less, except for $C_1$, which deviates − 0.06 A. The N—O group is tilted a little out of this plane, the distance from the approximating plane to the nitrogen atom being − 0.31 A., and from the oxygen atom − 0.19 A. The molecules make two kinds of contact with each other in the direction of the c-axis. The chlorine atoms of neighbouring molecules, which are related by the screw axes, make van der Waals' contacts, the Cl—Cl distance being 3.63 A. The molecules related by the centres of symmetry are grouped in pairs by much shorter distances, 2.82 A. between the nitrogen and oxygen atoms of the two neighbouring molecules. It is impossible yet to say what part the hydrogen atoms play in this system; their position may become clear in the three-dimensional electron density distribution which is now being calculated.

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## A New Method for Measuring Velocities of Ultrasonic Waves in Liquids

ULTRASONIC velocities in liquids determined by various methods have been reported in the literature. The interferometer method[1], though widely adopted by a number of workers, permits velocity measurements only at low ultrasonic frequencies. The Debye–Sears's diffraction method[2] and the Hiedemann method[3] of visibility are applicable only for the study of transparent liquids. Elaborate technique is required for velocity determinations by the pulse method[4].

In the method described here, a small liquid cell is constructed by cementing two thin cover-glass slips on either side of an annular brass disk of uniform thickness (2.48 mm.) and inside diameter of about 1 cm. A side hole is provided for the purpose of introducing liquids in the space enclosed by the cover-slips, which can be completely filled up by about 0.25 c.c. of liquid forming, as it were, a liquid plate of thickness 2.5 mm. Ultrasonic waves generated by a wedge are transmitted through this liquid plate and communicated to water contained in a glass trough which serves as the ultrasonic cell for obtaining the Debye–Sears's diffraction pattern. Resonance frequencies of this liquid plate are determined in the usual manner employing the wedge method[5]. The low order of the fundamental resonance frequency of the liquid plate enabled a number of transmission maxima to be obtained at close intervals with a single wedge of frequency range 3–6 Mc./sec. Using this set of transmission frequencies, the fundamental frequency and hence the velocity of sound in the liquid contained in the cell are evaluated. Results thus obtained for the velocities of sound in some liquids are shown in the accompanying table, along with those obtained by some of the other methods.

| | Fundamental frequency (Mc./s.) | Velocity calculated in metres per sec. at 30° C. | Velocities obtained by other methods (23–27° C.) |
|---|---|---|---|
| Glycerine | 0.390 | 1,950 | 1,986 (ref. 6) |
| Water | 0.304 | 1,520 | 1,500 (ref. 6) |
| Mercury | 0.285 | 1,425 | 1,440 (ref. 7) |
| Toluene | 0.260 | 1,300 | 1,300 (ref. 6) |
| Ethyl alcohol | 0.231 | 1,155 | 1,150 (ref. 6) |
| Carbon tetrachloride | 0.181 | 905 | 930 (ref. 6) |

The method is simple, rapid and highly accurate, being particularly suitable for liquids, both opaque and transparent, available only in very small quantities. In addition, it permits measurements of velocities over a wide range of frequencies. Further detailed investigations are in progress.

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## Abnormal Efficiencies in the Scintillation-counting of Gamma-Rays

IN an earlier communication, Mayneord and Belcher[1] have shown that, under appropriate conditions of high gain and low pulse-discrimination, the counting-rates for scintillations observed in a small calcium tungstate crystal irradiated by gamma-radiation approximate to the rates of absorption of gamma-ray quanta in the crystal calculated from theoretical linear absorption coefficients.

Similar observations on small crystals of thallium-activated potassium iodide show, however, that the counting-rates in this material may be many times greater than the calculated absorption-rates. This anomalous behaviour of thallium-activated potassium iodide, first reported by Freedman, Smaller and May[2], has been studied using experimental arrangements identical to those already described[1].

Fig. 1 shows the ratios, $R$, of the observed maximum counting-rates to the calculated rates of absorption of gamma-quanta derived from Klein–Nishina, Fowler–Hulme and Heitler theories, plotted as a function of crystal mass for crystals of equal cross-section, but varying thickness. Appropriate corrections have been made for background effects and scaler dead-time. Measurements were made for the gamma-radiation from various radioisotopes.

It will be seen that the observed rates are considerably greater than those calculated, and that the ratio of the two increases with increase in energy of the exciting radiation Further studies have shown that this effect is due to electron-trapping levels in the luminophor lattice, each gamma-quantum absorbed may thus produce a delayed phosphorescent emission consisting of single photons, in addition to a short-duration fluorescent pulse containing many photons Of these single photon pulses, a fraction, determined by the resolving time and optical efficiency of the system, will be recorded in the counter

We may expect that the number of phosphorescent centres excited by a single gamma-quantum absorbed in the crystal will depend on the energy of its secondary electron, and indeed will be linearly proportional to this energy. This is confirmed in Fig 2, where the ratio, $R$, of observed to calculated counting-rates for various radioisotopes in a crystal of mass 0 126 gm is plotted against the calculated mean energy, $\overline{E}_e$, of the secondary electrons produced in the crystal As expected, the experimental values fall approximately on a straight line, which when extrapolated intersects the vertical axis at unity, showing that the number of phosphorescent pulses, $R - 1$, counted for each quantum absorbed is linearly proportional to $\overline{E}_e$ The slight deviation from linearity in the case of the high-energy radiation of sodium-24 may be interpreted as being due to the escape from the crystal of some of the more energetic secondary electrons produced by this isotope before they have expended all their energy in exciting phosphorescent centres, the fall in the ratio of observed to calculated counting-rate apparent in Fig 1 in the case of the smallest crystal studied may also be explained in terms of this effect

Studies on the effect of scaler resolving time on counting-rate in thallium-activated potassium iodide show that the phosphorescent emission obeys a non-exponential decay law, it falls to half its initial value in 2 5 msec, but persists for many minutes after the initial excitation event Further observations on synthetic calcium tungstate indicate that this material also shows an impurity-activated phosphorescent emission, but of low intensity and of short duration The decay in this case appears exponential, with a half-life of 20 μsec (to be compared with the approximate figure of 100 μsec quoted by Garlick[3]) Thus, it is not appreciable at counter resolving times greater than 100 μsec Samples of purified anthracene and of anthracene-activated naphthalene have also been examined, but contrary to the reports of Cross[4] no phosphorescent emission has been detected in the samples tested

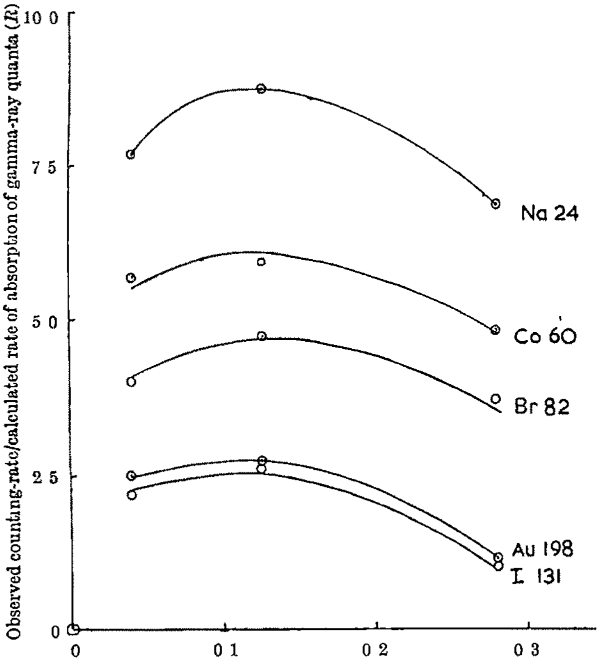

Fig 1 Relationship between counting-rate and rate of absorption of gamma-ray quanta in thallium-activated potassium iodide Resolving time, 10 μsec, photo-multiplier voltage, 1,080, amplifier gain, 16,000

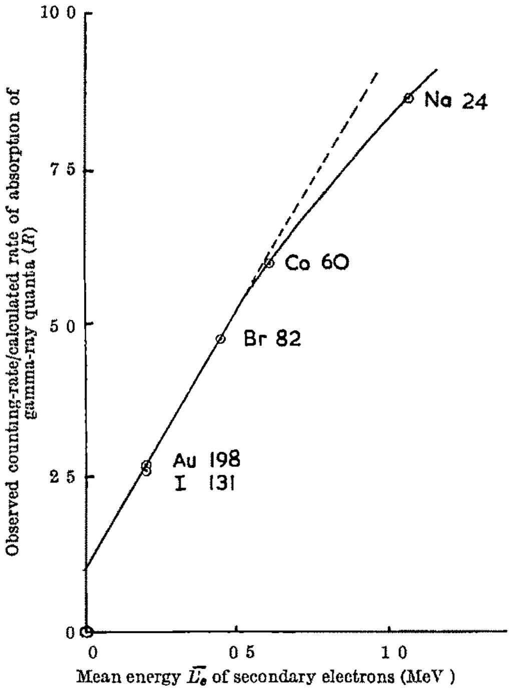

Fig 2 Relationship between counting-rate and energy of secondary electrons in thallium-activated potassium iodide Resolving time, 10 μsec, photo-multiplier voltage, 1,080, amplifier gain, 16,000, mass of crystal, 0 126 gm

Thanks are due to Mr J Sharpe, of the Atomic Energy Research Establishment, Harwell, for the gift of thallium-activated potassium iodide crystals, and to Dr G F J Garlick, of the University of Birmingham, for a sample of purified anthracene

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## Cross-Linkage Formation in Keratin

WHEN animal fibres, such as wool and hair, are treated with an acid solution of 3 4-*iso*propylidene 1 2-5 6-dianhydromannitol for 24 hr at 50° C, cross-linkages are formed between the carboxyl groups of neighbouring peptide chains[1] Since the fibres are then more resistant to deformation, their felting power is reduced, and attention has therefore been turned to the possibility of cross-linking wool with simpler di-epoxides, for example, 1 2-3 4-diepoxybutane (I) and 1 2-5 6-diepoxyhexane (II)

For this purpose, Lincoln wool fibres were purified by extraction with alcohol and ether, washed in distilled water, and then treated for 24 hr at 50° C with a 2 5 per cent solution of the di-epoxide in a phosphate buffer at the appropriate *p*H After being washed in running water for 24 hr , the fibres were examined for the presence of new cross-linkages by determining the extent to which supercontraction could be induced by boiling for 30 min in a 5 per cent solution of sodium metabisulphite[2] The results are given in the accompanying table

| *p*H | Percentage supercontraction of fibres treated with | | |
|---|---|---|---|
| | Buffer + I | Buffer + II | Buffer alone |
| 4 44 | 0 0 | 29 6 | 26 4 |
| 6 12 | 0 0 | 23 6 | 26 6 |
| 7 05 | 0 3 | 23 5 | 26 5 |
| 7 87 | 1 5 | 19 7 | 26 5 |

Unlike fibres treated with buffer alone, those treated with an acid solution of I fail to supercontract, and it is obvious that the reagent is capable of forming new cross-linkages between the peptide chains of animal fibres At first sight, therefore, it seems surprising that supercontraction should not be prevented by treatment with II, especially as a closely related compound—3 4-*iso*propylidene 1 2-5 6-dianhydromannitol—is known to cross-link keratin Wiggins and Wood[3] have, however, shown that II gives a furan ring, and not a tetrahydroxy compound, on being boiled in water, and its failure as a cross-linking agent may well be due to ring formation after primary reaction with the carboxyl groups of wool

We are indebted to the International Wool Secretariat for grants in aid of this investigation

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## Pyrophosphato-Complexes of Nickel and Cobalt in Solution

THE literature on complex pyrophosphates of nickel and cobalt does not record any detailed study of their solutions Rosenheim[1] observed that from solutions of alkali pyrophosphates containing nickel and cobalt pyrophosphates, the normal pyrophosphates separate unchanged Later, Bassett and his co-workers[2] stated that nickel and cobalt pyrophosphates dissolve in excess of alkali pyrophosphates giving yellowish-green and purple solutions respectively, but they could not isolate any complex salt in the solid phase This, however, does not show the non-existence of complex ions containing nickel or cobalt and pyrophosphate ion in solution I have investigated complex formation in solution by different physico-chemical methods such as thermometric, transport, conductometric, *p*H measurements, cryoscopy in saturated sodium sulphate solutions and magnetic measurements

Thermometric titration curves of alkali pyrophosphate solutions with nickel and cobalt salt solutions and vice versa indicate two breaks corresponding to the ratio of pyrophosphate to metal 2 1 and 1 1, which represent the formation of two complex ions with these ratios of the reactants Breaks due to the normal pyrophosphates are also observed in the titration curves

It is observed in transport measurements that the complex ion moves to the anode This observation rules out the possibility of formulæ of the complex ion in which the ratio of pyrophosphate metal is 2 1, namely,

$$[M(H_4P_2O_7)_2]^{+2} \text{ and } [M(H_3P_2O_7)_2],$$

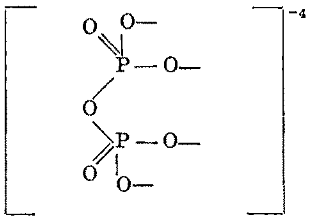
where *M* is nickel or cobalt Conductivity titrations of alkali pyrophosphates with nickel and cobalt nitrate solutions confirm the thermometric results that two complex ions in which the ratio of pyrophosphate metal is 2 1 and 1 1 are present in the solution With the addition of nickel or cobalt nitrate solution, the conductivity of the alkali pyrophosphate solutions either decreases very slowly or remains practically constant up to the point where the ratio of pyrophosphate metal is 2 1 This eliminates the formulæ $[M(H_2P_2O_7)_2]^{-2}$ and $[M(H_3P_2O_7)_2]^{-4}$ for the complex ion in which the ratio of pyrophosphate metal is 2 1, otherwise free hydroxyl ions will be produced and the conductivity of the alkali pyrophosphate solutions will increase up to the point where the ratio pyrophosphate metal is 2 1 Thus it is concluded that the complex ion is of the type $[M(P_2O_7)_2]^{-6}$ It may be supposed that the complex ion in which the ratio of pyrophosphate metal is 1 1 has the formula $[M(P_2O_7)]^{-2}$

*p*H titrations of sodium pyrophosphate solution with nickel or cobalt nitrate solution show a hump at the point pyrophosphate metal equal to 2 1, corresponding to the complex ion $[M(P_2O_7)_2]^{-6}$

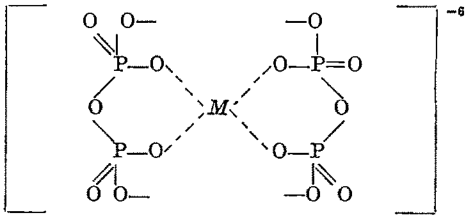
Cryoscopy measurements in saturated sodium sulphate solutions indicate that solutions in which the ratio pyrophosphate metal is 2 1 contain almost half the total number of pyrophosphate ions used That is, the complex ion $[M(P_2O_7)_2]^{-6}$ exists in simple monomeric form and the following equilibria exist in the solution

$$M^{+2} + P_2O_7^{-4} \rightleftharpoons [M(P_2O_7)]^{-2}$$
$$[M(P_2O_7)]^{-2} + P_2O_7^{-4} \rightleftharpoons [M(P_2O_7)_2]^{-6}$$

Assuming the structure of pyrophosphate ion to be



the complex ion of the type $[M(P_2O_7)_2]^{-6}$ may be represented as



with two six-membered rings

The possibility of co-ordinating with two other oxygen atoms of each pyrophosphate radical is eliminated by the fact that the rings formed will be four-membered, which are not very stable, and the co-ordination number of nickel or cobalt will be eight, which has not yet been observed in any of their complex compounds The usual co-ordination number of nickel and cobalt is six, so it is probable that the other two co-ordinating positions are occupied by water molecules But nothing can be said with any certainty, for the hydration of the complex ions in solution is not definitely known The complex ion of the type $[M(P_2O_7)]^{-2}$ can be represented in a similar way with a six-membered ring

Magnetic susceptibility measurements with solutions containing sodium pyrophosphate and nickel or cobalt chloride give the effective magnetic moments of the complex ions $[Ni(P_2O_7)_2]^{-6}$ and $[Co(P_2O_7)_2]^{-6}$ as 3 281 and 4 937 Bohr magnetons respectively These values indicate that the complex ions have ionic bonding

The behaviour of pyrophosphato complexes of nickel and cobalt in solution is found to be similar to that of copper, the results of which I have already reported[3]

My thanks are due to Prof P B Sarkar for his interest and laboratory facilities, and also to Prof P Ray for allowing me to take the magnetic measurements in his laboratory

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May 30

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## An Improved Method of Detecting Sugars on Paper Chromatograms

MOST of the methods of detection of sugars depend upon the formation of furfurals by the treatment of the sugar with mineral acid or fairly strong organic acid (for example, trichloracetic acid), and subsequent formation of a coloured compound with an amine or a phenol The most common faults of the reagents hitherto tried are (1) a partial destruction of the paper, making it fragile, (2) a dark background colour, (3) poor distinction between the various classes of sugars

To avoid the destructiveness of large quantities of mineral acid, we decided to try various phenols and amines with traces of hydrochloric acid The use of very dilute aqueous hydrochloric acid or aqueous/alcoholic acid did not prove successful Success was obtained, however, with solutions of phenols and amines in absolute alcohol to which small quantities of acid (0 1–0 5 ml of 4 *N* hydrochloric acid) had been added It was found later that improved results were obtained by decreasing the volatility of the reagent by the addition of *n*-butanol to the mixture The best results were obtained with a β-naphthylamine spray of the following composition absolute alcohol 50 ml, *n*-butanol 50 ml, 3 8 *N* hydrochloric acid 0 4 ml, water 0 2 ml, β-naphthylamine (pure) 0 1 gm, ferric sulphate 10 per cent solution, 1 drop Spray evenly and dry at 160–170° for about ten minutes

Fructose is the first to show and gives a bright yellow spot, changing to yellow-brown This is characteristic of fructose and those oligosaccharides which yield fructose on hydrolysis Methyl pentoses behave similarly, but give a duller yellow The pentoses appear rather slowly and give a bright pink-red colour Aldoses give a light brownish colour The method gave positive results with the following sugars *aldohexoses* mannose, glucose, galactose, *ketohexoses*. fructose, sorbose, *pentoses* arabinose, ribose, lyxose, xylose, *methyl pentoses* rhamnose, fucose, *disaccharides* maltose, cellobiose, lactose, melibiose, sucrose, *trisaccharides* raffinose

The paper is unaffected by the acid even at such a high temperature as 170° and the background colour is very pale

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## $C_{18}$ Unsaturated Acids of Butterfat

IT has been generally assumed that the $C_{18}$ unsaturated acids of butterfat comprise mainly oleic acid with some octadecadienoic acid (3–5 per cent of the total fatty acids) and traces of octadecatrienoic acid (cf Hilditch[1]) In this Laboratory the $C_{18}$ unsaturated acids of New Zealand butterfat have been submitted to alkali isomerization using the technique of Hilditch, Morton and Riley[2], and it has been found that the octadecatrienoic acid content is of the same order as that of the octadecadienoic acid, as shown in the accompanying table

COMPOSITION OF THE $C_{18}$ UNSATURATED ACIDS OF BUTTERFAT
(Results expressed as a percentage of the total $C_{18}$ unsaturated acids)

| Sample | Octadecadienoic | | Octadecatrienoic | |
|---|---|---|---|---|
| | Non-conjugated | Conjugated | Non-conjugated | Conjugated |
| New Zealand butterfat (churned 28/6/48) (Methyl esters sap equiv 295 7, iod val 94 0) | 1 27 | 1 31 | 3 14 | Trace |
| New Zealand butterfat (churned 14/3/49) (Methyl esters sap equiv 294 9, iod val 97 7) | 4 63 | 0 51 | 2 83 | 0 05 |
| English butterfat (Hilditch and Jasperson, ref 3) | 2 0 | 2 0 | 0 2 | Trace |

It is thought that the differences in octadecatrienoic acid content between the New Zealand and English butterfats examined may be due to differences in linolenic acid content of the diet, the English butterfat being possibly from animals which had been stall-fed, whereas the New Zealand butterfat is produced almost entirely from a pasture diet, the main fatty acid constituent being linolenic acid From time to time investigators[3-5] have indicated the probable presence of traces of linolenic acid in butterfat, and more recently Mattsson[6], using spectroscopic measurements after alkali isomerization, has inferred the presence of substantial amounts (0 7–2 0 per cent) in Swedish butterfat By fractional distillation of the methyl esters, Mattsson was able to attribute the observed absorption at 232 mμ and 268 mμ almost entirely to $C_{18}$ unsaturated acids It is admitted, however, that it had not been definitely shown by isolation of pure hexabromide or of other derivatives that butterfat does contain linolenic acid

In this Laboratory, by submitting butterfat acids to low-temperature crystallization from acetone at $-50°$ C, followed by fractional distillation of the methyl esters, a concentrate of highly unsaturated $C_{18}$ acids (iodine value 151 3) was obtained Bromination of this concentrate under the conditions described by White and Brown[7] yielded hexabromostearic acid (m p 180–181°, not depressed on admixture with authentic hexabromostearic acid) in amounts corresponding with the presence of 14 02 per cent linolenic acid, as compared with 14 99 per cent obtained by the alkali isomerization technique of Hilditch, Morton and Riley[2] There seems, therefore, little reason to doubt that the octadecatrienoic acid content of New Zealand butterfat consists almost entirely of linolenic acid On the other hand, in agreement with the extensive researches of Hilditch[1] on English butterfat, it appears most improbable that the octadecadienoic acid of New Zealand butterfat is linoleic acid, as the ether-soluble, petroleum ether-insoluble bromides yielded no tetrabromostearic acid (m p 114°), even when submitted to recrystallization from hot petroleum-ether according to the technique of Hilditch and Shorland[8], by which it is possible to detect small amounts of added linoleic acid in admixture with other polybromides These findings may be contrasted with those of White and Brown[9], who claim to have established in samples of butterfat that two-thirds to three-quarters of the octadecadienoic acid is ordinary linoleic acid The detailed report of this work is awaited with interest

It has been previously suggested[10] that animal fats may be divided into two classes, homolipoid and heterolipoid, according to whether or not their composition is readily affected by the incorporation of dietary fatty acids Beef tallow[11] has been shown to contain not more than traces of linolenic acid, while the present investigation establishes the presence of appreciable amounts of linolenic acid in milk fat It appears, therefore, that not only are there species differences in regard to the influence of the dietary fat upon the composition of the depot fat, but also that within a given species the various fats are affected in varying degrees by the composition of the dietary fat

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## Instantaneous Electron Transfer and Interaction Absorption

ISOTOPIC exchange by electron transfer between complex ions containing an element in different oxidation states has been demonstrated for quite a number of elements In some instances, such as

$$[\mathrm{Fe(CN)_6}]^{\equiv} + [\mathrm{Fe^*(CN)_6}]^{\equiv} \rightleftharpoons [\mathrm{Fe^*(CN)_6}]^{\equiv} + [\mathrm{Fe(CN)_6}]^{\equiv}$$

the exchange is so rapid as to seem instantaneous[1] Systems containing an element in two oxidation states sometimes exhibit abnormally deep and intense colorations For example, crystals of $(\mathrm{NH_4})_2\mathrm{SbCl_6}$, which are believed to contain the complex ions $[\mathrm{SbCl_6}]^{3-}$ and $[\mathrm{SbCl_6}]^{-}$, are jet black[2] The coloration of both solid $(\mathrm{NH_4})_2\mathrm{SbCl_6}$ and its solutions is so much more intense than that produced by the component complex ions separately that it is described as arising from interaction absorption

An attempt has been made recently to test the hypothesis that there is a correlation between instantaneous exchange by electron transfer and interaction absorption[3] The result was inconclusive, mainly because of the great difficulty of deciding whether any exchange involving radioactive isotopes is instantaneous or not There is apparently no sure way of discovering whether an exchange involving radioisotopes occurs in solution before separation, or whether it occurs during the separation of oxidized and reduced forms of the complex ions[4]

Because it is possible to detect rapid electron transfer without any chemical or physical separation of oxidized and reduced forms, the system D-$[\mathrm{Os^{II}(dipy)_3}]$ $(\mathrm{ClO_4})_2$ and L-$[\mathrm{Os^{III}(dipy)_3}]$ $(\mathrm{ClO_4})_3$ lends itself to testing the hypothesis that rapid electron transfer is accompanied by interaction absorption We have accordingly examined mixed solutions of $[\mathrm{Os^{II}(dipy)_3}]$ $(\mathrm{ClO_4})_2$ and $[\mathrm{Os^{III}(dipy)_3}]$ $(\mathrm{ClO_4})_3$ for interaction absorption in the region 7,000–4,000 A In view of the high dilution of the solutions used ($5 \times 10^{-4}$ *M*), for which exchange was complete in less than 15 sec, it is perhaps not surprising that we failed to find any interaction absorption Nevertheless, the failure does prove that there is no correlation between the two phenomena

Since these experiments were completed, Bonner[5] has shown that even in solutions which exhibit interaction absorption (solutions containing trivalent and pentavalent antimony), electron transfer may be quite a slow process Further evidence against the above hypothesis has been adduced by Pauling[6] in a discussion of the origin of the colour of crystals of $\mathrm{Cs_2Au_2Cl_6}$, which are black The existence in these crystals of two distinct complexes, namely, linear $[\mathrm{Au^{I}Cl_2}]^{-}$ and square $(\mathrm{Au^{III}Cl_4})^{-}$, rules out the possibility that the intense colour is due to resonance of electrons among the metal atoms

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June 26

[1] Thompson, *J Amer Chem Soc*, **70**, 1045 (1948)

[2] Elliott, N, *J Chem Phys*, **2**, 298 (1934)

[3] Whitney, J, Browne, C I, McConnell, H, and Davidson, N, Brookhaven Conference Report, Chemistry No 2, p 196 (1948)

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[5] Bonner, N A, *J Amer Chem Soc*, **71**, 3909 (1949)

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# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Monday, October 30

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Discussion on "Projection- versus Direct-Viewing Television in the Home" (to be opened by Mr W T Cocking)

### Tuesday, October 31

Manchester Geographical Society (in the Geographical Hall, 16 St Mary's Parsonage, Manchester), at 6 30 p m —Mr J R Hulme "Bermuda and the West Indies"

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 6 30 p m —Mr A R Aikman "The Frequency Response Approach to Automatic Control Problems"

Royal Anthropological Institute (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 8 p m —Prof W E Le Gros Clark, F R S , and Dr L S B Leakey "The Miocene Apes of Kenya"

### Wednesday, November 1

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Mr Ernest W Goodale "Celebrating a Great Centenary" (Inaugural Address)

University of London (at Bedford College for Women, Regent's Park, London, N W 1), at 5 15 p m —Sir David Brunt, F R S "Weather Lore" (Stevenson Lecture)

Society of Public Analysts and other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 7 p m —Scientific Papers

### Thursday, November 2

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 2 30 p m —Symposium on "Tropolones and Allied Compounds" (introduced by Prof J W Cook, F R S )

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Mr W K Burton and Mr N Cabrera "Equilibrium Structure of Crystal Surfaces" , Mr W K Burton, Mr N Cabrera and Mr F C Frank "A Theory of Growth of Real Crystals"

Mineralogical Society (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Discussion of a Report on "The Education and Training of Electrical Technicians" (to be presented by Sir Arthur Fleming)

British Institution of Radio Engineers, Merseyside Section (at the Electricity Board Service Centre, Whitechapel, Liverpool), at 6 30 p m —Mr D W Heightman "Propagation of Metric Waves beyond Optical Range"

Chemical Society, Nottingham Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Nottingham), at 6 30 p m —Prof C W Shoppee "The Cortisone Problem"

Chemical Society, Bristol Section (joint meeting with the Royal Institute of Chemistry and the Society of Chemical Industry, in the Chemistry Department, The University, Bristol), at 7 p m —Dr J S Anderson "The Hahn Emanation Technique"

University of London (in the Chemistry Theatre, University College, Gower Street, London, W C 1), at 7 p m —Prof R A Fisher, F R S "Creative Aspects of Natural Law" (Arthur Stanley Eddington Memorial Lecture) *

British Institution of Radio Engineers, North-Western Section (in the Reynolds Hall, College of Technology, Manchester), at 7 15 p m —Mr W R Cooper "Communication Cables"

Institution of Works Managers, Bristol Branch (at the Royal Hotel, Bristol), at 7 15 p m —Mr J C W Stead "Time Study and Incentives"

### Friday, November 3

Chemical Society, St Andrews and Dundee Section (joint meeting with the St Andrews University Chemical Society, in the Chemistry Department, United College, St Andrews), at 5 p m — Prof J N Davidson "Chemical Aspects of the Cell Nucleus"

British Paper and Board Makers' Association, Technical Section, Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p m —Dr E Waters "The Psychology of Colour"

### Saturday, November 4

Royal Institute of Chemistry (in the Zoology Lecture Theatre, The University, Reading), at 2 30 p m —Dr G W Scott Blair "Recent Developments in Rheology"

British Interplanetary Society (in the Tudor Room Caxton Hall, Westminster, London, S W 1), at 6 p m —Mr J Humphries "The Earth's Atmosphere" , Mr T R F Nonweiler "Problems of High Speed Missiles entering the Atmosphere"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer in Chemistry up to special degree standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (November 4)

Assistant (female) in the Economics and Statistics Section of the Commercial Department, at headquarters in London, for the collation, analysis and interpretation of statistics relating to the production, distribution and sales of electricity to consumers—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W 1, quoting AE 111 (November 6)

Lecturer and an Assistant Lecturer in Geography—The Secretary of University Court, The University, Glasgow (November 11)

Assistant Lecturer in Inorganic and Physical Chemistry—The Registrar, Queen Mary College, Mile End Road, London, E 1 (November 13)

Director of the New Horticultural Centre of the Ministry of Agriculture at Loughgall, County Armagh—The Secretary, Civil Service Commission, Stormont, Belfast (November 13)

Regional Director for the North Region of the County Advisory Service—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C 2 (November 13)

Lecturer in Psychological Medicine—The Secretary of University Court, The University, Glasgow (November 15)

H M Inspectors of Factories, Class II (men and women), in the Ministry of Labour and National Service—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 3333 (November 16)

Scientist, Grade III, on the staff of the Director-General of the Scientific Department at headquarters in London, for duties mainly concerned with progressing research work—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/265 (November 16)

Agricultural Research Officers (with an honours degree in agriculture of an approved University or an equivalent qualification, and extensive knowledge of tropical or sub-tropical agriculture) in the Department of Research and Specialist Services, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W C 2 (December 23)

Agronomist in the Department of Agriculture, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/249

Assistant Soil Conservation Officer in the Sudan Ministry of Agriculture—The Sudan Agent in London, Wellington House, Buckingham Gate London, S W 1, endorsed 'Soil Conservation 4/196'

Engineer (Hydrology) in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27322/192

Engineer (Water Supplies) in Mombasa, Kenya—The Director of Recruitment (Colonial Service) Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27329/27

Industrial Chemist or Chemical Engineer as Assistant to Chief Chemist for new cement factory in Uganda—The Uganda Electricity Board, 129 Grand Buildings, Trafalgar Square, London, W C 2

Lecturer in Bacteriology—The Principal, South African Native College, Fort Hare, C P , South Africa

University Demonstrator for market research and analysis—The Secretary, Agricultural Economics Research Institute, Parks Road, Oxford

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Department of Scientific and Industrial Research Index to the Literature of Food Investigation Vol 20, Nos 1–2, June Compiled by Agnes Elisabeth Glennie, assisted by Margit Matthews and Igor Zacopanay Pp iv+90 (London H M Stationery Office, 1950 ) 6*s* net [247

Aluminium Development Association Information Bulletin No 17 Aluminium Alloy Castings Pp 48 (London Aluminium Development Association, 1950 ) 1*s* [257

British Standard 18 1950, Tensile Testing of Metals Fourth revision Pp 20 2*s* 6*d* net British Standard 868 1950, Cod Oil for Sulphonation, First revision Pp 16 2*s* net (London British Standards Institution, 1950 ) [257

Medical Research Council Special Report Series, No 267 Researches on the Radioactivity of Oral Cancer By Constance A P Wood and J W Boag (with P Howard-Flanders, A Glucksmann, L H Gray and F G Spear) Pp 148+30 plates (London H M Stationery Office, 1950 ) 12*s* 6*d* net [257

Thirtieth Annual Report of the Board of the Institute of Physics. Pp ii+12 (London Institute of Physics, 1949 ) [257

Bulletin of the British Museum (Natural History) Entomology, Vol 1, No 2 A Revision of the Family Ceracidae (Lepidoptera, Tortricoidea) By A Diakonoff Pp 171–219 10*s* Entomology, Vol 1, No 3 The Early Literature on Mallophaga, Part 1 By Theresa Clay and G H E Hopkins Pp 221–272+2 plates 10*s* (London British Museum (Natural History,) 1950 ) [257

Second Report of the Committee on Industrial Productivity (Cmd 7991) Pp 10 (London H M Stationery Office, 1950 ) 4*d* net [267

Third Annual Report of the Advisory Council on Scientific Policy, 1949–1950 (Cmd 7992) Pp 18 (London H M Stationery Office, 1950 ) 6*d* net [267

Registrar General's Statistical Review of England and Wales for the Year 1948 New Annual Series, No 28 Tables, Part 1, Medical Pp viii+362 (London H M Stationery Office, 1950 ) 7*s* net [317

British School of Archaeology at Athens Annual Report of the Managing Committee for the Session 1948–1949 , Archaeology in Greece 1948–1949, by J M Cook Pp 38+3 plates (London British School of Archaeology at Athens, 1950 ) [317

The Task of Rationalism By A Gowans Whyte Pp ii+20 (London Watts and Co , Ltd , 1950 ) 6*d* net [317

General Register Office Registrar General's Quarterly Return for England and Wales Births, Deaths and Marriages, Infectious Diseases, Weather, Survey of Sickness, Population Estimates, Quarter ended 31st March 1950 Pp 36 (London H M Stationery Office, 1950 ) 1*s* net [18

Library Association Year Book 1950 Pp 525 (London Library Association, 1950 ) 11*s* , to Members of the Library Association, 8*s* 6*d* [18

Journal of Atmospheric and Terrestrial Physics Editor-in-Chief, Sir Edward Appleton (About every 2 months ) Vol 1, No 1 Pp 64 (London Butterworth-Springer Ltd , 1950 ) 70*s* per Vol [148

City and County of Bristol The City Museum Report of the Committee for the Year ended 31 December 1949 Pp 16+2 plates (Bristol City Museum, 1950 ) [148

University of Reading National Institute for Research in Dairying Report for the Year 1949 Pp 80 (Reading National Institute for Research in Dairying, Shinfield, 1950 ) [148

Wye College Department of Hop Research Annual Report, 1949 Pp 55 (Wye Wye College, 1950 ) 3*s* [158

Science Museum One Hundred Years of Submarine Cables By G R M Garratt Pp viii+60+16 plates (London H M Stationery Office, 1950 ) 2*s* 6*d* net [158

Experimental and Research Station, Cheshunt Annual Report (Thirty-fifth Year), 1949 Pp 80+6 plates (Cheshunt Nursery and Market Garden Industries' Development Society, 1950 ) [158

Air Ministry Meteorological Office Professional Notes No 102 Sandstorms on the Northern Coasts of Libya and Egypt By E A Lunson (M O 524b ) Pp 12 (London H M Stationery Office, 1950 ) 4*d* net [158

Birmingham and its Regional Setting a Scientific Survey Prepared for the Meeting held in Birmingham, 30th August–6th September 1950 (Published by the Local Executive Committee ) Pp xix+334 (London British Association for the Advancement of Science, 1950 ) [168

Annual Reports on the Progress of Chemistry Vol 46, 1949 Pp 334 (London Chemical Society, 1950 ) 25*s* [168

Colonial Development Corporation Annual Report and Statement of Accounts for the Year ended 31st December 1949 Pp vi+70 (London H M Stationery Office, 1950 ) 2*s* net [168

## Other Countries

World Health Organization Technical Report Series No 16 Joint FAO/WHO Expert Committee on Nutrition , Report on the First Session Pp 24 (Geneva . World Health Organization , London H M Stationery Office, 1950 ) 1*s* 3*d* , 15 cents [177

German Hydrographic Institute, Hamburg Annual Report No 4, 1949 Pp 68 (Hamburg German Hydrographic Institute, 1950 ) [177)

Journal of the California State Dental Association Vol 26, No 3, May–June 1950, Supplementary Issue Sugar and Dental Caries , a Symposium presented as part of the Eightieth Annual Meeting, California State Dental Association, April 24, 25, 26, 1950, San Francisco, California Pp 95 (San Francisco, California State Dental Association 1950 ) [177

Dominion Museum Records in Zoology Vol 1, Nos 3–6 Papers on Mollusca By R K Dell Pp 21–58 (Wellington Dominion Museum, 1950 ) [177

Smithsonian Institution United States National Museum Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1949 Pp iii+123 (Washington, D C Government Printing Office, 1950 ) [177

Report and Accounts of the National Botanic Gardens of South Africa, Kirstenbosch, Newlands, Cape, and the Karoo Garden, Worcester, for the Year ending 31st December 1949 Pp 20 (Newlands, C P National Botanic Gardens of South Africa, 1950 ) [177

Sveriges Geologiska Undersokning Ser Aa, No 191 Beskrivning till kartbladet Untra Av R Sandegren och P H Lundegårdh Pp 107 (Stockholm P A Norstedt and Soner, 1949 ) 4 kr [177

Bulletin of the Museum of Comparative Zoology at Harvard College Vol 103, No 6 Distribution and Origin of the Birds of Mexico By Ludlow Griscom Pp 339–382 Vol 103, No 7 New and Little Known Cartilaginous Fishes from the Atlantic By Henry B Bigelow and William C Schroeder Pp 383–408+8 plates (Cambridge, Mass Harvard College, 1950 ) [247

Report of the Scientific Advisory Board for the Year 1949 Pp xii+307 (New Delhi Indian Research Fund Association, 1950 ) 1 rupee [247

Geological Society of South Africa Alex L du Toit Memorial Lectures, No 1 The Life and Work of Dr Alex du Toit By T W Gevers Pp 109 (Johannesburg Geological Society of South Africa, 1950 ) [247

British Territories in Borneo Report of the Geological Survey Department for the Year 1949 By F W Roe Pp iv+106 (Kuching Government Printing Office, 1950 ) 2 dollars , 4*s* 8*d* [247

Universidad Nacional de Tucuman Publicación No 464 (Instituto de Fisica, No 24) Correccion de la temperaturas medidas con pirometros opticos y de radiacion Por Jose Wurschmidt Pp 28 Publicación No 492 (Instituto de Fisica, No 29) El sistema MKS y la ensenanza de la fisica Por Jose Wurschmidt Pp 24 (Tucuman Universidad Nacional, 1949–1950 ) [247

Commonwealth Scientific and Industrial Research Organization Bulletin No 247 Marine Crayfishes (Spiny Lobsters), family Palinuridae, of Western Australia , with particular reference to the Fishery on the Western Australian Crayfish (*Panulirus longipes*) By Keith Sheard Pp 45 (Perth Government Printer, 1949 ) [247

Australian Journal of Marine and Freshwater Research Vol 1, No 1, April Pp 154 (Melbourne Commonwealth Scientific and Industrial Research Organization, 1950 ) 7*s* 6*d* [247

Impact of Science on Society (Quarterly) Vol 1, No 1, April–June Pp 36 (Paris Unesco, 1950 ) 25 cents , 1*s* 6*d* [257

Fieldiana Botany, Vol 27, No 1 Contributions to the Flora of South America—Studies on Andean Compositae, 1, Studies in South American Plants, 2 By José Cuatrecasas Pp 113 (Chicago Field Museum of Natural History, 1950 ) 1 75 dollars [257

Iraq Natural History Museum Publication No 2 A Handlist of the Birds of Iraq (with Short Notes on their Status in the Country) Compiled by Bashir E Allouse Pp 70 (Baghdad Government Press, 1950 ) [257

Pontificiae Academiae Scientiarum Scripta Varia 7 Semaine d'étude sur le problème biologique du cancer Pp xiv+348+20 plates (Citta del Vaticano Pontificia Academia Scientiarum, 1949 ) [257

Gold Coast Colony Report to the Secretary of State for the Colonies by Dr G B Jeffery on a Visit to West Africa, December 1949 to March 1950 Pp 16 (Accra Government Printing Department , London Crown Agents for the Colonies, 1950 ) 2*s* [277

Unesco Centro de Cooperación Cientifica para América Latina Scientific Institutions and Scientists in Latin-America—Argentina 2° volumen Pp ii+103 Scientific Institutions and Scientists in Latin-America—Brasil 1er volumen Pp iv+139 2° volumen Pp ii+305 (Montevideo Unesco Centro de Cooperación Cientifica para America Latina, 1950 ) [317

West African Cacao Research Institute Annual Report, April 1948 to March 1949 Pp 64 (Tafo West African Cacao Research Institute , London Crown Agents for the Colonies, 1950 ) 5*s* [317

City of Launceston Annual Report of the Queen Victoria Museum and Art Gallery, 1948–49 Pp 8 (Launceston Queen Victoria Museum and Art Gallery, 1950 ) [317

Indian Central Cotton Committee Technological Bulletin, Series A, No 72 Technological Reports on Standard Indian Cottons, 1949 By D L Sen Pp iv+75 1 8 rupees Technological Bulletin, Series A, No 73 Technological Reports on Trade Varieties of Indian Cottons, 1949 By D L Sen Pp vii+91 2 rupees (Bombay Indian Central Cotton Committee, 1949–1950 ) [317

Ceylon Part 4 Education, Science and Art (F) Administration Report of the Director of National Museums for 1948 By P E P Deraniyagala Pp F 17+2 plates 55 cents Part 4 Education, Science and Art (E) Administration Report of the Director of National Museums for 1949 By P E P Deraniyagala Pp E 26+1 plate 55 cents (Colombo Government Publications Bureau, 1949–1950 ) [317

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge Hors Série Recherches chimiques sur les alcaloïdes de l'Erythrophleum Par Dr R Tonduer Pp 52 50 francs Série scientifique No 47 Étude pédologique d'un essai de fumure minérale de l'Elaeis à Yangambi Par H Laudelout Pp 21 25 francs (Bruxelles Institut National pour l'Étude Agronomique du Congo Belge, 1950 ) [317

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# AIR RECONNAISSANCE AND ARCHÆOLOGICAL DISCOVERY

AIR photography is now recognized as a means of archæological discovery which yields results unobtainable by any other method This special applicability is due to the power of an aerial camera to record the earth's surface comprehensively, including not only all major features shown on large-scale maps, but also many minor and often transient details that maps do not present The present form of any given landscape is the result of a long and complicated development by Nature and man, and each feature in it reflects some part of that process That is why air photography has come to be extensively used for geological survey, since the detailed picture of physical features which it affords often supplies information about geological structure Artificial elements in a landscape, on the other hand, include not only the present cultural pattern but also remains of every period since man first left his mark upon the surface The most obvious of these remains still exist above ground, and embrace a wide variety, from structures in earth or stone, belonging to prehistoric and Roman times, to medieval villages, castles and abbeys, all plain to see and readily studied on the ground Yet they also include very many structures, now covered by arable land, which have been so reduced or masked by agriculture that they are difficult to plan, and often scarcely perceptible to an observer walking over them Such sites may be effectively photographed in morning or evening sunlight when low banks and ditches cast the long shadows that emphasize minor features in faint relief

In the right conditions, however, air photography has much to reveal of buried features of which there are no surface traces whatever Land which has long been under plough may cover completely obliterated ancient sites An air observer may see them outlined or patterned by differences in the soil, or in the colour and growth of vegetation above them Such soil-marks or crop-marks often give an extraordinarily detailed picture of buried features In fact, photographs taken under good conditions may not only disclose a new site, but also, by showing its detailed plan, indicate clearly its character and period

These principles, simply enough stated, cover a wide range of conditions, for in practice the revelation of a given site depends upon the soil, the vegetation and its state of growth, and the weather, both at the time of photography and during the preceding season In general, long-rooted cereals, viewed in late spring and early summer, give the most sensitive renderings Root crops, if they respond at all, give only a blurred image of major disturbances in the soil Grass is seldom responsive, except in drought Thus in any given year only a certain proportion of agricultural land is likely to yield results , but if a site is observed over a period of years it will sooner or later be in the right state for observation, as each year brings different crops to each field in rotation Nevertheless, the limitations described are heavily outbalanced by the vast quantity of material available The main problem to-day is not the finding of new sites, but rather how best to record the information in the limited time available for observation, for each group of subjects has its season Earthworks in open country are best photographed in winter and spring, when least obscured by vegetation, and when the sun is low Soil-marks go with the fresh ploughing in autumn and early spring Crop-marks, by far the most productive source of new discoveries, demand observation in spring and early summer, while crops are still green

Present agricultural conditions in Great Britain offer exceptional opportunities for this work and create a new urgency Land development is now planned on an increasing scale, exploitation of land not normally brought under the plough, the so-called marginal land, inevitably affects many earthworks, so that either the last chance is now passing of observing them in unploughed state, or new opportunities are coming for viewing the same works as crop-marks This information may be recorded in two ways There are high-altitude vertical photographs taken for another purpose, such as the National Air Survey. But these photographs are secured at any convenient time of the year, and therefore crop- and soil-marks only occur in them by chance Their greatest value to archæology lies in their record of earthworks in grass or moorland which have hitherto escaped notice on the ground Scrutiny of all such photographs, especially of unploughed land, is thus well worth undertaking, and their relatively small scale is partly compensated by the fact that they overlap and may be viewed stereoscopically But it is the second method of photography that is the better This is low-altitude reconnaissance specially undertaken for the purpose and planned in relation to particular needs at the appropriate time for observation

Some of the results of the application of air photography, and particularly the planned reconnaissance, have become common knowledge The Stonehenge Avenue, the prehistoric religious site at Dorchester, in Oxfordshire, Celtic fields on Salisbury Plain, and Roman town-plans at Caistor-by-Norwich or at St Albans, are outstanding examples in Great Britain Special reconnaissance flights undertaken each summer since the Second World War have yielded a large quantity of material, illustrating many periods of prehistory and history In the Neolithic age, a number of new examples of the *cursus*, a very long and narrow rectangular ditched enclosure, has been found, extending the known area of distribution of these monuments Photographs of Neolithic hill-top camps disclose fresh details of these sites Discoveries of new religious monuments have been made at Birrens in Dumfriesshire, at Coupland (Northumberland) and at Elston (Notts)

A large number of Iron-Age hill-forts has been photographed from the air Not only have new forts been discovered in this way, but also knowledge of sites already known has been greatly increased, since photographs show that the forts have often undergone an unexpectedly long and complicated structural development Native villages and prehistoric agriculture are other subjects illuminated by air photography Many ancient earthworks are difficult to date in isolation, but an air photograph will often show them in visible relationship to known remains, thus either establishing their relative age or showing where planned excavation can attack the question

Air photography has greatly increased our knowledge of both the military and civil districts of Roman Britain In the north a large number of new forts, signal-stations and temporary camps has been found along already known lines of advance, and elsewhere, in districts not previously known to have been penetrated, as, for example, western Dumfriesshire and Galloway In the south, the discovery of military sites on Watling Street offers an unexpected chance of learning about the early history of the Roman conquest Important discoveries have been made in the civilian sphere One hundred acres of the plan of the tribal capital of Wroxeter in Shropshire have been recorded on air photographs that reveal not only the street-plan but also public buildings, shops and large town-houses, and even mosaic or concrete floors In the smaller towns significant new features have been seen and photographed at Catterick, Kenchester, Stretton Bridge, Irchester and Mildenhall (Wiltshire) Country houses, Romano-British villages and the associated fields are other subjects upon which air photography has thrown much light

Earthworks of the Dark Ages and of the medieval period call for detailed examination from the air Existing remains are often difficult to recognize and to interpret, but it should be possible to date them in relation to other features Traces of abandoned medieval villages are common in many parts of Britain A comprehensive air survey showing these settlements, their drove-roads and related agriculture, would provide invaluable material for historical and economic studies

The early history and prehistory of Britain can thus be studied from the air more effectively than in any other way yet available It is of the greatest importance and urgency to record this rich historical material now The surface of Britain is to-day undergoing change at a greater rate than ever before New building, open-cast mining, afforestation and more intensive agriculture are covering or obliterating large areas of countryside and effectively destroying any archæological sites that lie there While land utilization can take account of visible remains, planning based upon visible remains cannot allow for sites which leave no trace on the surface Yet it is these sites that often contain the most important material for history

A planned programme of air photography over the next few years is the only possible way of securing the necessary record Moreover, the time available is limited In many cases it will be either now or never, for the opportunity once lost will never return

It must be emphasized that the very richness of the British Isles in crowded and superimposed cultures makes them an area of unique importance for regional and historical studies, a heritage not merely of national value but also one in which all the civilized world may claim a share

# EINSTEIN AND RELATIVITY

### The Meaning of Relativity

By Albert Einstein Fourth edition. Pp v+146 (London Methuen and Co , Ltd , 1950 ) 7*s* 6*d* net

THIS book is a new (the fourth) edition of Einstein's Stafford Little Lectures, delivered in May 1921 at Princeton University, supplemented by two appendixes, one on the "Cosmologic Problem", the other on the "Generalised Theory of Gravitation" It is the latter appendix which will attract the attention of physicists and mathematicians, because it contains the first complete account of Einstein's new attempt to establish by *a priori* reasoning the fundamental law of physics But this appendix cannot be properly understood without a careful study of the whole book, and whatever the reader may think of the somewhat hazy view from the summit, he will enjoy the path which leads up to it In fact, Einstein's presentation of the special and the general relativity is so simple, clear and convincing, that it can not only be recommended to students as a first introduction, but will also provide material for thought to scholars who are interested in the logical and empirical basis of the theory The last chapter of the book ends with a consideration of Mach's ideas about the origin of inertia in connexion with the question of whether space is finite and closed, or infinite and open This cosmologic problem is taken up in a wider frame in Appendix 1, which gives an account of Friedman's original theory Later contributions to the theory of the expanding universe, the work of Lemaître, Robertson, Eddington, Milne and others, are not mentioned

Appendix 2 is a confession of Einstein's deepest convictions about the structure of the material world, which have alienated him from the general trend of contemporary physics He starts with the remark that the fundamental law of general relativity, which equates the contracted curvature tensor of space-time to the energy tensor of matter, is unsatisfactory because of its dualistic character, and he proclaims his aim to establish a unitary theory, in which there exists only one field, subject to a law of the form some generalization of the curvature tensor is zero No separate energy tensor of matter ought to be introduced , it should later appear automatically if the new equations of the unitary field are split in two parts, one representing the action of inertia and gravitation, the other the rest of physical phenomena

The natural way of obtaining the postulated generalization is, according to Einstein, the introduction of a metric tensor $g_{il}$ which is not symmetrical It can, of course, be split into a symmetric and skew-symmetric part, and it might be expected that the latter has something to do with the electromagnetic field The objection may be raised that these asymmetric $g_{kl}$ are not an irreducible set of quantities, since each of the two parts is by itself a tensor Einstein rejects this group-theoretical point of view as not being the only relevant one, and shows that a coherent tensor calculus based on the non-symmetrical metric tensor can be developed and leads to reasonable results Thus Einstein arrives at field equations of the formal type required The main difficulty is the proof of the compatibility of the equations The question now arises whether Einstein's equations fulfil his expectations of providing the foundations of a rational theory of matter There is, however, no answer , the book ends with the sentence that these equations "form a system, of utmost simplicity, compatible in the usual sense" No solution and no discussion of the physical content are given

What we have before us might therefore be better described as a programme than a theory Einstein obviously hopes that his equations may have solutions which lead to the localization of energy, usually described as quanta, and to the laws of distribution of these quanta in agreement with wave mechanics

The motive behind this programme is Einstein's well-known philosophical attitude He believes that quantum mechanics is unsatisfactory, because it describes, not the behaviour of an objective world, but rather the reaction of the physical objects to the experimental conditions Therefore he tries to find a theory of the classical type of such refined structure that it contains the essential features of atomistics and quantum theory as consequences There are at present few physicists who share this view However, most of them will agree with Einstein that the final synthesis of relativity and quantum theory has yet to be made

MAX BORN

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# TOWN PLANNING

### Cities in Evolution

By Patrick Geddes Edited by the Outlook Tower Association, Edinburgh, and the Association for Planning and Regional Construction, London New and revised edition Pp xxxi + 241 (London Williams and Norgate, Ltd , 1949 ) 18*s* net

"CITIES in Evolution" was first published in 1915, just after the total loss of Geddes's first Town Planning Exhibition *en route* to India, and, apart from his earlier comprehensive study of the town planning of Dunfermline, undertaken at the request of Andrew Carnegie and published in 1903 under the title "City Development", it is the only book on civics and urban development that Geddes wrote The book was intended to help the citizen to understand urban processes and to secure his active co-operation in urban development Geddes's immediate influence was mainly direct and personal , but probably no one has done more to inspire the planning of cities and of regions to-day, and the reappearance of a volume which has so long been out of print should enable a new generation to judge for themselves how much the best elements in such planning owe to the thought of Geddes

The present volume, however, is not simply a reprint of the original edition Four chapters in that edition, those dealing with the homes of the people, the housing movement, a town-planning tour in Germany, and recent progress in housing and town planning, and all but two paragraphs of a chapter on German organisation have been omitted as being no longer of interest Most of the deletions, which have been agreed between Dr A Geddes, Mr Phipps Turnbull and Sir George Pepler are fully justified, and any omissions are more than balanced by the inclusion of fresh material which gives the modern reader a clearer idea of the range of Geddes's social philosophy The introduction includes an extract, dealing with the Valley Section, from a lecture given by Geddes at the New School of Social Research in New York City in 1923, which illustrates his use of the historical and geographical survey of occupations as an approach to regional development and city planning Illustrations selected from Geddes's second Town Planning Exhibition are accompanied by a text drawn from his catalogue to the first Exhibition These illustrations replace the original illustrations for the book Next, in an appendix, his diagram of the Notation of Life is reproduced with an explanatory note on it by Geddes himself, and an appreciation of the importance of the contribution of his graphic presentation of interrelated phenomena to the growth of a synthetic or unitary form of thought A chapter from Geddes's "Sunday Talks with my Children", and a description with extracts from his final Dundee lecture, "A Botanist Looks at the World", completes the new material

The outstanding impression on reading or re-reading this representative sample of Geddes's thought on cities and on civilization is the relevance of much of his views to post-war planning and reconstruction to-day, and the remarkable extent to which he has anticipated, where he may not have inspired, comparatively recent developments or trends of thought Geddes's approach to his subject was coloured by his training as a biologist, and his general habit of mind also made him an ecologist long before ecology was regarded as a special discipline In this book he is arguing on the lines that to-day have led to the establishment of the Nature Conservancy or, in a wider field, inspired the holding last year at Lake Success of the United Nations Scientific Conference on the Conservation and Utilization of Resources, though he has tended to overestimate the direct effect of technical advances on social life, and to underestimate the extent to which surviving social institutions and customs can subvert both science and technology

That, of course, only justifies Geddes's concentration on education rather than politics as the primary task Mr Lewis Mumford, who freely acknowledges his own indebtedness to Geddes, has, indeed, characterized Geddes's most important contribution to the planning of cities, not as that of a bold innovator in urban planning, but as an ecologist, as the patient investigator of historical origins and social traditions and of dynamic biological and social interrelationships He had grasped forty years ago the latent idea of the neighbourhood unit and the essential importance not only of the individual but also of the small group in which the free expression of personality, of interest and of service is possible His outlook and method contribute to the planning of to-day precisely those elements that the administrator and bureaucrat are prone to disregard or omit Each valid scheme, Geddes insists, should and must embody the full utilization of local and regional conditions, and be the expression of local and regional personality

"Cities in Evolution" is a book to be read and studied not only by all responsible for town and country planning or concerned with any aspect of social or physical planning, but also by those who are concerned with the whole problem of local government and the maintenance or emergence of conditions in which an effective democracy is possible Geddes makes plain in this book the immense complexity of the whole subject of town or city planning —the necessity for time and patience and care of detail, the meticulous regard which must be paid to the interrelation of past and future But, most of all, he emphasizes the importance of the human scale and the human purpose above all merely mechanical requirements, and of a readiness to leave an essential part of the process to the ultimate consumers or citizens who are most intimately concerned with it For that insistence upon sympathy and human understanding, upon—to use the phrase that he and Branford coined—the resorption of government, the reappearance of this exposition of Geddes's philosophy of planning is to be welcomed The book should be widely road and appreciated, and may well give a fresh impetus to creative thought in this field, as well as check some of the excesses which have marred some post-war developments R BRIGHTMAN

## PSYCHOLOGICAL ILLNESS

### Textbook of Abnormal Psychology

By Prof Carney Landis and M Marjorie Bolles Revised edition Pp xi+634 (New York The Macmillan Company, London Macmillan and Co, Ltd, 1950) 37*s* 6*d* net

THIS is a revised version of the authors' previous text-book, and they say with truth that it is significant that their book has become outdated within five years There used to be a complaint against text-books that they were copied from each other and contained no recent work It was easy to discover this, since poor documentation made it impossible to find the origin of the material presented No one can make a similar complaint against this excellent text-book At the end of each chapter there is a list of ten to fifteen references, mainly from journals, and in the front are acknowledgments of direct quotations, figures and tables used in the compilation

The authors attempt to give a fair presentation of the known facts of psychological illness, and although case-histories are given they are not used, as is so often the case, to pad out the work, but are really illustrative of the diseases described

The book is divided into five sections. The first is mainly introductory but includes a chapter on psychopathology This is eclectic and includes the work of Kretschmer, Kraepelin, Meyer and Freud The second section is devoted to descriptions of various mental diseases with illustrative cases The third is explanatory, with chapters on heredity, culture and environment, development and so on Section 4 is devoted to psychopathology and is influenced by the old-fashioned functional psychology —it gives disorders of sensation, impairment of intellect, diseases of volition and so on, as if these were separate entities The authors very reasonably excuse this by pointing out that they do so because "(*a*) it brings the material in line with normal psychology, and (*b*) most of the psychological experiments have been conducted and reported in these terms Until such time as a more adequate system of classification of psychological phenomena is formulated, and until the facts now arranged in the older classifications are translated into some new system, the conventional system, admittedly unsatisfactory, is still preferable " The final section is concerned with psychodiagnosis, the law and treatment.

In general, the illustrations of diseases, most of which are drawings, are good, but one or two fall from the high standard, for example, the sketch of a cretin on p. 272 does not show the characteristics of the disease sufficiently to help in diagnosis to those unfamiliar with the condition

The descriptions are good, and the book avoids he excessive Americanisms which are so irritating and puzzling to those who have not lived in the United States The care with which the book has been compiled makes it a pleasure to look up a fact, and the reader can be sure of finding the latest nformation on almost any psychiatric subject

CLIFFORD ALLEN

# ESSENTIAL OILS OF THE CITRUS AND MINT FAMILIES

The Essential Oils

By Dr Ernest Guenther Vol 3 Individual Essential Oils of the Plant Families *Rutaceae* and *Labiatae* Pp xvi + 777 (New York D Van Nostrand Co, Inc, London Macmillan and Co, Ltd, 1949) 75*s* net

IN this third volume Dr Ernest Guenther begins to speak of trees, though, inverting Solomon's order, he has placed the hyssop near the beginning of his discourse and reserved the cedar, no doubt, for later treatment The order chosen is, in fact, that of commercial importance, giving priority accordingly to the two botanical families which include peppermint, lavender and the citrus group

The alternative of classification on a taxonomic botanical basis may well have appeared a tempting one A phylogeny of plants in terms of their chemical components, elegantly illustrating the achievements of the morphologist and resolving his dilemmas, seems one of the most attractive prospects which chemistry may still have to offer Bold spirits, quoted in Dr Guenther's first volume, have already "distinguished species indistinguishable by ordinary morphological techniques, on the basis of the production of oils of different chemical composition" A more modest example from the present volume, namely, Fujita's chemical demonstration of the interrelations of fifteen species of the tangled labiate genus *Orthodon*, may be mentioned as noteworthy, inasmuch as Fujita's work is not otherwise easily accessible

On the other side, the present volume cites cases of distinctly different oils being produced in identical conditions by trees showing, at most, the differences of horticultural strains of one and the same variety Throughout the book, moreover, there is ample evidence of the dependence of essential-oil composition on the phase of maturity of the plant, and on geographical, ecological and less tangible factors, some of which are further detailed below If a taxonomy by essential-oil content is ever to be constructed, Dr Guenther's work will provide a rich quarry of the necessary material, and the "table or key showing the classification of the oils according to a modern botanical system", envisaged as an item in his final volume, must be awaited with interest For the present, however, the choice of a perspective which relegates this mistier outline to the background seems well advised

These volumes may therefore be taken as primarily for the benefit of essential-oil producers and consumers and the analysts who advise them There is much wisdom in the warning that "the two points of view—one aimed at finding out what is wrong with the oil, and the other at trying to define the facts relative to pure oils—not infrequently lead to different conclusions" In effect, it is to the convenience of the consumer to define the authenticity of any oil by analytical criteria as sharp and narrow as possible, but with this ambition the enterprise of the producer, complementing that of Nature, is continually in conflict

Within the past decade, large-scale essential-oil industries have been developed in areas more or less remote from the original homes of the plants concerned The Argentine is now a large producer of peppermint oil, Brazil of the menthol-rich oil of corn-mint In the U S S R, though information from there is found confused and contradictory, at least the foundations of a large lavender industry appear to have been laid (it is of interest to note that, in comparing the oil yields of more than nine hundred strains, a count of the oil-sacs on only five sepals is said to give a satisfactory assessment of the productivity of any one strain) Change of habitat on this scale must always be a probable source of change in the characters of the relevant oil Of this there is a striking example in the mandarin and tangerine oranges, which for oil-producing purposes in the eastern hemisphere have usually been considered synonymous, but which in Brazil yield oils of decidedly different character, while in North America the oil is wholly of the type 'tangerine', with optical rotation much higher than in any mandarin oil (The American idiom which distinguishes these oranges with flexible and smoothly peeling skin as the 'kid-glove' type is one at which it is surely proper to pause and admire)

To variations of this kind must now be added those which are beginning to be produced by artificial genetic modifications, for example, in the tetraploid peppermints recently obtained at Purdue University by colchicine treatment, and the artificial hybrids, said to contain oil-constituents not present in the parents bred by Russian workers from species of *Ocimum* Notice should also be taken of variations in oil character correlating with changes in extraction technique, especially in the citrus fruits A much increased demand for citrus juices fitted for beverage purposes, coinciding over recent years with a declining importance of citrus pulps, compared with the fermentation-vat, as a source of citric acid, may involve changes in processing quite sufficient to modify the analytical character of the oil, and to raise a doubt of its authenticity if judged by any too dogmatic criterion Through these pitfalls for the authenticating analyst, Dr Guenther must prove an invaluable guide In at least one matter of nomenclature, also, he is consistent in a usage which might avoid no little confusion if generally adopted, namely, the treatment of the descriptions "neroli" and "petitgrain" purely as adjectives, respectively equivalent to "distilled from flowers" and "distilled from shoots" and meaningless in themselves until the name of the tree concerned is added

In its detailed structure, the book is a series of monographs on all the recognized varieties of the oils within its scope, covering history, production technique and statistics, analytical characters and as much detail of chemical composition as is available With the examples of the first two volumes before us (see *Nature*, **163**, 663, 1949 and **164**, 895, 1949) it is scarcely necessary to say that it is excellently produced and indexed, though it may be observed that, in both index and text, hesperetin is misprinted in a form, hesperitin, which could confuse it with hesperidin

E G KELLETT

## The Dianthus

A Flower Monograph By Will Ingwersen Pp 128+29 plates (London and Glasgow Wm Collins, Sons and Co, Ltd, 1949) 10*s* 6*d* net

THE genus *Dianthus* is at once a group of plants that appeals equally to the horticulturist, to the botanist and to all those who love plants for their colour, scent and beauty It is a genus to which the breeder has paid considerable attention, and, if the outcome of his efforts has not infrequently been to produce types that are both ill-proportioned and scentless, he has also produced others that are real acquisitions to the rock garden and the border, such as 'Charles Musgrave' In the pages of this book Mr W Ingwersen writes, if all too briefly, of the many-sided attractions of these plants—something of their history as garden plants, from the sixteenth-century carnations and pinks to the many hybrids of recent production

The species exhibit a narrow range of colour, if we exclude the yellow *Dianthus aridus* and *D knappii*, which latter, despite the author's criticisms, can be attractive with appropriate culture and suitable setting Many species have long been cherished for their perfume, whether it be the fringed and scented flowers of *D superba*, the sweet fragrance of the white *D squarrosus*, the massive odour of the clove carnations, the elusive scent of the Sweet William, or the pervading odour of *D nolanus* Distribution, propagation and hybridization are concisely dealt with, but most of the space is devoted to the species and garden hybrids about which the author writes with first-hand knowledge and imparts valuable experience respecting their culture Not the least biologically interesting feature of perennial *Dianthus* species is their varied span of life from *D alpinus*, which often survives only three years, to the long-lived *D arboreus*

The work is illustrated with some excellent flower portraits in black-and-white and some, mostly less excellent, portrayals in colour The book is one that should be on the shelves of every *Dianthus* enthusiast, if only for the author's illuminating comments from a wide experience E J SALISBURY

## Engineering Science

By H B Brown and A J Bryant Vol 3 Pp viii+531 (London Macmillan and Co, Ltd, 1950) 10*s* net

IN the scheme of instruction for national certificates in engineering, 'Engineering Science" is a comprehensive subject which runs continuously through the three years of the ordinary course In the third year, it comprises several branches previously treated as separate subjects, such as applied mechanics, hydraulics, strength of materials, theory of machines and heat engines In many respects, this no doubt is an advantage as it ensures a broad foundation of knowledge being available for continued study or for application in practice, and gives the student a clearer perception of the essential unity of those branches of the subject

One result of the syllabus is that it has made necessary a new type of text-book, and authors are presented with the problem of giving unity and balance to a treatise dealing with so many diverse phases and presenting them as a single logical subject In the present volume, the authors have shown that this problem can be resolved within the scope of a convenient text-book It is the third of a series designed to cover the three-year course in this subject, and graded to meet the student's attainments at each stage In the third year the student has reached the calculus, and in this volume free use of it is made Experimental work, testing and full-scale trials of prime movers have been given an important place, and the numerous examples have been carefully selected to give a practical association with the problems of design and operation towards which the reader is progressing A notable feature of the presentation is the clear and concise way in which the descriptions and explanations have been given

In addition to the requirements of the ordinary national certificate, its scope includes that of the engineering science course of the secondary technical school and also, in large measure, those of the syllabuses of the Institution of Mechanical Engineers examinations and others which demand engineering science as an integral part of their syllabuses It should prove of considerable use to designers, draughtsmen and industrialists when questions of principle and application arise

## Chymia

Annual Studies in the History of Chemistry Tenney L Davis, Editor-in-Chief (Edgar F Smith Memorial Collection) Vol 2 Pp x+144+21 plates (Philadelphia University of Pennsylvania Press, London Oxford University Press, 1949) 32*s* net

IN a foreword to this second volume of "Chymia", the editors announce that Tenney Lombard Davis, distinguished as an organic chemist and a master in the field of the history of chemistry, had passed away in the interval between its publication and that of the first volume, to which he gave much of his time and energy All interested in the history of chemistry will feel the loss which science and culture in general have sustained in his death

The present volume contains an interesting paper by him on the *pulvis fulminans* There are also papers on such subjects as the alchemical interests of Newton (in which the publication of D McKie on this subject should certainly have been mentioned), ambergris in India, the atomic theory before Boyle (in which no mention is made of the detailed study by Partington), and Sir Kenelm Digby, as well as others The publication of successive volumes of "Chymia" continues to add to the high reputation which this series of studies in the history of chemistry has established

J R P

## A Textbook of Colloid Chemistry

By Prof Harry Boyer Weiser Second edition Pp x+444 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1949) 33*s* net

THIS is a review of colloid chemistry written mainly from the classical point of view and, within these limitations, is reasonably comprehensive The discussion of modern techniques, such as X-ray diffraction and light scattering, is inadequate, and the reader will have to search elsewhere for useful knowledge on these topics The documentation of the subject which, in the case of this second edition, is presumably carried to the later part of 1948, is presented in a somewhat one-sided fashion The author has a praiseworthy grasp of American work but tends to neglect European, and particularly British, contributions to the field These omissions detract from the value to a student of an otherwise pleasing book which treats a number of important aspects of colloid science with clarity and effectiveness

## Kleine Kryptogamenflora von Mitteleuropa

Von Prof Dr Helmut Gams Band 1 Die Moos- und Farnpflanzen (Archegoniaten) Dritte verbesserte Auflage Pp iv+186 (Jena Gustav Fischer, 1950 ) 9 40 D marks

THIS excellent little book should be brought to the notice of all 'rucksack' travellers interested in the lower plants It is a complete and usable guide to the liverworts, mosses and ferns of Central Europe, although in size it is scarcely larger than a British passport In format it resembles Pascher's "Susswasserflora" Thanks to Prof Gams's experience as a teacher, the analytical keys are eminently usable Diagrams are numerous and clear, and very great care seems to have been taken in the compilation of synonyms, which are extensively quoted, and in the provision of information on habitats and localities The two previous editions came out in 1940 and 1948 respectively, so that this one is fully revised For its size it is a very remarkable achievement, and will have uses far beyond the geographical area for which it was designed

## Organic Reactions

Vol 5 Roger Adams (Editor-in-Chief) Pp viii+446 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 48*s* net

THIS series of publications, invaluable to organic chemists, was begun in 1942, and the five volumes issued to date, containing altogether 1,740 pages, cover some fifty of the outstanding reactions of organic chemistry The present volume follows the lines of the admirable scheme laid down at the outset, and the descriptions, documentation and tabulation conform to the high standard of accuracy and completeness characteristic of the series The subjects of the ten chapters comprise the synthesis of acetylenes, cyanoethylation, the Gattermann–Koch and Leuckart reactions, selenium dioxide oxidation, the Hoesch synthesis, the Darzens glycidic ester condensation, together with further treatments of the Diels–Alder and Friedel and Crafts reactions and the preparation of organic fluorine compounds JOHN READ

## The Use of Geography

By Prof Frank Debenham (Teach Yourself Geography Series ) Pp 206 (London English Universities Press, Ltd , 1950 ) 6*s* net

PROF F DEBENHAM has taken a rest from his more serious studies on the formation and growth of the Ross Ice Barrier and the water supplies of Central Africa, and allowed himself to play with anecdote and incident in the problems of academic geography from which he has recently retired This little volume is mostly an introduction to a small series of geographies written by Cambridge men, each of which is to illustrate one aspect of the Cambridge school It gives a rapid survey of the history of geography and shows the different approaches to the study of place

While Prof Debenham more than once assures us that he is all in sympathy with the human geographer, he succeeds in showing that his preference, in fact his creed, is on the physical side, including cartography In these branches the Cambridge school excels He seems a little suspicious of the human and social side, but he must admit that it is prominent in many university schools, and he does admit that Cambridge is not the only school Perhaps as a concession Prof Debenham allows the value of the individual student's regional essay in humanizing the physical basis It is a most readable essay, for Prof Debenham is never boring, but, as usual, is fresh, lively, full of ideas and tolerant of all opinions honestly held As for the use of geography, the subject seems as much to interest and amuse us as to have any other end But as taught by Prof Debenham it could never be dull R N R B

## Theory of Knowledge

An Introduction By A D Woozley (Hutchinson's University Library, No 33 ) Pp 196 (London Hutchinson's University Library, 1949 ) 7*s* 6*d* net

HALF a century ago, the theory of knowledge was regarded as a very advanced subject, only discussed by fellows of colleges, a few canons residentiary, and a headmaster or two (of the ancient foundations) Not so to-day, however, for that fashionable universal, the plain man, apparently wants to study epistemology, and indeed he is fortunate to have a book like this to begin with Mr A D Woozley gives all the essentials of judgment, the correspondence and coherence theories of truth, and much else besides, with commendable clarity, and not a little wit .If a comment is allowable, it is that the amount of space devoted to memory seems a little excessive But apart from that, the balance is masterly

There are several illustrations from natural science, showing the value of discrimination in the use of evidence This should appeal to university students, whatever their subject, as well as to the amateur In addition, the approach is to some degree historical, which enables the reader to discern how some of the tenets, at first sight outrageous, came to be modified and tempered in the flame of continuous criticism The proof-reading must have been first-class I have noticed only two misprints, in fact the same one twice F I G RAWLINS

## Structure and Development of the Vertebrates

A Manual for an Integrated Course in Comparative Anatomy and Embryology By Prof Florence Moog (Prentice-Hall Animal Science Series ) Pp xiii+170 (New York Prentice-Hall, Inc , 1949 ) 4 65 dollars

THIS book is an interesting attempt to provide an integrated course built on the theory that "students should be thoroughly grounded in the essentials of embryonic form and development before plunging into the complexities of comparative anatomy itself" It is essentially a practical manual, but the subject-matter is dealt with more fully, and in a more interesting manner, than is usual in such books The course begins with a study of the anatomy of the ammocœtes larva of *Petromyzon*, and then passes on to the embryology of the frog and the chick Next follow two useful essays on homology and recapitulation, which serve as an introduction to comparative anatomy This is discussed system by system, and there are also chapters on gametogenesis, fertilization and the placenta

The standard most closely approximates to that of British sixth-form school, or first-year university, courses However, while the novelty of the approach may attract some, the book is not closely adapted to British needs The use of *Necturus* as a type limits its value , and, although the production is beautiful, it is sad to have to say that the artificiality of its price, the result of devaluation, is almost sufficient in itself to exclude it from British laboratories

W S BULLOUGH

# DATING THE PAST BY RADIOACTIVE CARBON

THE use of radioactive carbon for the estimation of the age of archæological objects has attracted widespread attention At the recent Birmingham meeting of the British Association, it was the subject of a joint discussion of Sections A (Mathematics and Physics) and H (Anthropology and Archæology) Contributions were made by J V P Long, F E Zeuner and K P Oakley The method was conceived by Dr W F Libby of the Institute for Nuclear Studies of the University of Chicago[1], and he and his co-workers have been able to design the necessary apparatus for the application of the method to certain types of archæological material

Briefly, the method relies on the fact that neutrons from cosmic rays are captured by atmospheric nitrogen The nucleus formed disintegrates immediately, casting out a proton, and a carbon atom of the atomic weight 14 is left These atoms are radioactive and disintegrate by expelling an electron, the half-life being $5,568 \pm 30$ years[2,3] With the expulsion of the electron the atom reverts to ordinary nitrogen of atomic weight 14 During their period of existence, the atoms of carbon-14 enter into the carbon dioxide of the atmosphere in much the same way as do the atoms of normal carbon (carbon-12 The concentration of carbon-14 in the atmosphere is about $10^{-12}$ gm per gram of carbon-12 Since carbon dioxide provides virtually all the carbon used by plants in building up their tissues, the isotopic composition of carbon in living vegetable matter must be the same as that of atmospheric carbon, and the same applies to living animals, all of which ultimately derive their body material from the plant kingdom But once an organism is dead, it will no longer receive carbon of atmospheric composition, and its content of carbon-14 will disintegrate according to its half-life period The proportion of carbon-14 to carbon-12 in dead organic matter, therefore, is a direct function of the time elapsed since the death of the organism, and this provides the means of dating the organism by isotopic analysis of its carbon

Because of the very small quantity of carbon-14 present even in living organic matter, the apparatus used has to be extremely sensitive Of the two possibilities of introducing carbon into the counter tube, either as carbon dioxide or in a solid form, Dr Libby has favoured the latter alternative It has been necessary to screen the apparatus very carefully from external sources of radiation, mainly from cosmic rays, which bombard the counter tube at the rate of about 350 counts per minute, while 1 gm of carbon gives not more than about 12 counts per minute The reduction of the background count, therefore, is a serious problem, which Dr Libby has solved by arranging other counters around the carbon counter and by shielding the apparatus by sheets of lead and iron[3]

Mr J V P Long, of the National Physical Laboratory, Teddington, however, is optimistic about the possibility of using gas counters While the screening precautions would obviously have to be the same, the preparation of the samples is simpler in the case of gas counters, and accuracy of the counts is likely to be higher according to Mr Long's observations

The carbon-14 method rests on a number of assumptions. Several of these, like the constancy of cosmic radiation throughout the period involved, are implied in its physical aspects But apart from these there are some geological and archæological assumptions which deserve close attention The first of these is that carbon-14 is evenly distributed in living matter For example, Dr Libby considered it possible that, because of the latitudinal variation of cosmic radiation, latitudinal differences may exist in the isotopic composition of the carbon in woods grown in different geographical latitudes An assay of fourteen woods[4] has shown clearly that there is no such correlation with geographical latitudes On the other hand, the range of results is considerable, which raises the question of whether carbon-14 may be taken up selectively by various species of organisms This possibility can no longer be ruled out, since Nier[5] has recently found that, in the formation of carbonates, carbon-13 is favoured compared with carbon-12 He has also found that plants are relatively enriched with carbon-12 compared with carbon-13 What applies to carbon-13 might equally, if not more so, apply to the still heavier isotope carbon-14 It will be necessary, therefore, to study a much larger number of Recent samples than has hitherto been done, and it might even become necessary to compare samples of the same material only

The second assumption is that unaltered samples are available It may be safely assumed, for example, that specimens of wood taken from Egyptian rock tombs have preserved their carbon exactly as required and have not suffered contamination But this does not apply to samples taken from open-air sites, where they have been exposed to weathering processes This applies in particular to specimens of charcoal, which are otherwise very suitable for isotopic analysis. Charcoal is strongly adsorbent, and since solutions containing humic substances pass through the soil while weathering is in progress, charcoal is likely to adsorb quantities of substances which contain carbon of younger age than that of the charcoal itself Similarly, a contamination with younger humic substances is liable to occur in peats In such cases it will be necessary to beware of contamination and if possible to develop a cleaning process which extracts the adsorbed organic substances without affecting the original material

Other sources of contamination are of a technical kind It is obviously necessary to shield specimens from exposure to sources of radioactivity But some rather elementary precautions are very easily overlooked Thus, samples may have been treated with preservatives or wrapped in tissue paper, cotton wool, or anything that might add Recent carbon to the sample A particularly dangerous source of contamination is fungal and bacterial growth on the specimen It occurs very readily if specimens are packed in air-tight containers in a moist condition, as is often done by archæologists The sample may afterwards be dried and all external evidence of the growth removed Nevertheless, there may be enough Recent organic matter left in the sample to reduce its apparent age very considerably

The third assumption is that the carbon of the sample was 'Recent' carbon at the time when the specimen became an object of archæological interest This assumption may be erroneous in two very different respects First, the material may have been old at the time when it was used For example, wood, when made into an article by man, is not necessarily quite recent Thus it is well known from the ring-counts carried out by Dr Douglass and his collaborators in the south-western United States that beams, sometimes hundreds of years old, were used again and again in the construction of Indian pueblos The use of old wood must have been very common in countries where this raw material was relatively scarce

On the other hand, although the raw material may have been quite 'recent' at the time of its becoming an archæological specimen, the carbon of which it is composed need not always be 'recent' carbon of that time It will almost certainly be nothing but 'recent' carbon in the case of vegetable matter, since plants derive their carbon from the atmospheric carbon dioxide Molluscan shells, however, are a different matter As they are often available in quantities in archæological sites, their calcium carbonate affords a good source of carbon for investigation But it is not certain whether the isotopic constitution of such carbon corresponds to that of the atmosphere when the mollusc was alive It may have taken up carbonates, for example, from Palæozoic limestone, and incorporated it in its shell This adds a complication to the use of carbonates In addition to the possibility of selective intake of carbon-14, as suggested by Nier's discovery of the favoured intake of carbon-13 in the formation of carbonates, very little is known about the processes of building up of molluscan shells A special investigation may become necessary if the use of carbonates for carbon-14 age estimates is to be developed

The ordinary method is restricted to the last 20,000 years, which can be extended to the maximum of 30,000 years by enriching in a thermal diffusion column[1] It is virtually limited to the Late Palæolithic, Mesolithic, Neolithic and Bronze Age periods Physicists are actively improving their apparatus and refining the analytical technique According to Dr. Oakley's report, one of the troubles encountered by Drs Libby and Arnold is the difficulty of removing completely the magnesium oxide from the carbon after its reduction from carbon dioxide It has been solved for the time being by making a correction for unremoved magnesium oxide It is, however, urgently necessary to study also the geological and prehistoric aspects of the method in order to eliminate the sources of error involved in the sampling New developments may well emerge from such work Thus, the use of flotation methods for the recovery of finely divided carbon from prehistoric hearths and occupation layers had been suggested, and Dr Oakley stated that American workers have had some success using zinc chloride

In spite of its limitations and difficulties, the carbon-14 method of dating promises to settle many outstanding chronological problems, such as the beginning of food production, and the first colonization of America Some of these were discussed at the Viking Fund Seminar in Physical Anthropology held in June in New York, at which Dr Oakley was present The last (Mankato) advance of the Wisconsin glaciation passed over tree trunks the age of which by the carbon-14 method is of the order of eleven thousand years, that is, less than half the age expected by geologists This is the time when man is believed to have first appeared in North America Dates from occupation sites in the western United States are of the order of 7–10,000 years In the eastern United States, the earliest cultures are proving to be later than in the west Carbon-14 dates suggest that man spread there about five thousand years ago

Check samples from sites in Egypt and Syria dated by historical evidence have produced satisfactory results[6] Dr Braidwood, of the Oriental Institute of the University of Chicago, has great hopes that the carbon-14 method will help in the dating of the appearance of agriculture in the Near and Middle East[7] At the recent Zurich session of the International Congress of Prehistoric and Protohistoric Sciences, Braidwood reported on some preliminary results based on carbon-14 determinations, which seem to confirm the beginning of the First Dynasty of Egypt at about 3000 B C, and that primitive agriculture was already being practised in the Kurdish hills at about 5000 B C

F. E ZEUNER

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# LANDSCAPE EVOLUTION IN GREAT BRITAIN

AMONG the discussions at the Birmingham meeting of the British Association was one carried on by geographers and geologists (Sections E and C) on "The Pre-Glacial Evolution of the British Land Surface" This topic is one of real importance to both groups of workers To the geographer seeking an explanation of the complex relationships which obtain between the different elements of the physical and cultural landscapes of his own country, some understanding of the stages by which the former developed is vital The key to the role and relationships of soils, surface forms and ground-water conditions in the present landscape lies often in the phases of its past evolution To the geologist concerned with elucidating the geological history of Britain, the record of the evolution of the land surface is a chapter which should not be ignored Yet ignored or overlooked it certainly has been. Only in the volcanic districts of Antrim and the Hebrides in the north-west, and in East Anglia and the London and Hampshire Basins in the south-east, is there direct stratigraphical witness as to what was going on in Britain in Tertiary time, and geologists have therefore devoted themselves to the task of piecing together the record of earlier phases of our palæo-geography from the rich records of the Palæozoic and Mesozoic successions, or have devoted themselves to the complexities of the glacial, interglacial and post-glacial successions As Prof S W Wooldridge remarked in the course of his presidential address to Section E, "by a combination of physical chance and human perversity the Tertiary era has almost become a neglected 'Dark Age' in the geological history of Britain" A joint discussion of geologists and geographers intended to throw light on the problems of this 'Dark Age'—which the radioactive clock tells us was sixty-five or seventy million years long—is therefore greatly to be welcomed, and if the lamps held up at Birmingham cannot be said to have cast their light very far into its depths, it is certain that their beams are turned in the right direction

Geomorphology offers two contrasted and complementary lines of approach to the problem, namely, by the elucidation of denudation chronology and by the reconstruction of the original pattern of our drainage system The latter is possible at all only by virtue of the fact that when a new cycle of erosion begins as the result of general uplift, the landscape inherits the rivers of the previous cycle unless these have been extinguished by a marine transgression Not all the rivers so inherited will survive long, and not all of them belonged to the initial drainage pattern But some of our present-day rivers may be older than any feature of our present land-surface, and in applying this method to the Midland region of Great Britain (in a very wide sense of that term) Prof D L Linton made this claim for the North Welsh Dee where it crosses the Berwyn Hills, and for the south-flowing streams of the southern Pennines and notably the Derbyshire Derwent From these and other surviving remnants he reconstructed a Proto-Trent, with headwaters as far west as Snowdonia, which flowed eastwards across the North Midlands receiving the Derwent and its analogues as left-hand tributaries, and the ancestors of the present north-flowing Penk, Tame and Soar from the right, and flowed into the North Sea beyond the site of the Wash An east–west watershed, he argued, bounded this system from that of a comparable proto-Thames to the south, also carrying Welsh water to the North Sea, while to the north other workers have stressed the importance of the east-flowing element in the original drainage of Yorkshire, Durham and Northumberland, and even beyond the Border

Later work in many parts of Britain will be necessary to establish such a reconstruction and to give it precision, but if it be allowed that the general pattern of our earliest rivers is being revealed, it becomes clear that the movements that brought it into existence comprised a widespread, though not uncomplicated, tilting from west to east Prof Linton would identify this movement with those known to have upraised the Chalk before the deposition of the basal Eocene strata of the London Basin, and if he is correct some new light is thrown on the earliest episodes in our Dark Age

The later phases are better illumined by tracing the remnants of former valley floors or of base-levelled surfaces of wider extent Such work must needs be detailed and precise, and therefore local, and the interim results of work being carried on in three widely separated areas—Exmoor, County Clare and the Derby–Staffordshire border—were presented by Mr W G V Balchin, Dr Marjorie M Sweeting and Mr G T Warwick Each has recognized a series of landscape features corresponding to periods of stillstand and has designated those periods by a non-committal local terminology The question of correlating the stillstands of one region with those elsewhere had already been taken as far as it can profitably be taken at present by Prof Wooldridge in his presidential address, and it was therefore not pursued But a point that was taken up in general discussion concerned the question whether the surfaces at higher levels are marine or sub-aerial Mr Warwick's succession of inland stages is wholly sub-aerial, and Dr Sweeting's partly so, Mr Balchin's stages at comparable altitudes are all marine and regarded as successive strand-flats cut during the discontinuous emergence of south-western England from the sea If this emergence is regarded, as it is by Mr Balchin, as being due to a succession of eustatic drops in sea-level, a somewhat wholesale late-Tertiary submergence of the English lowland would seem to be implied—a conclusion not in accord with the drainage reconstructions so far made The eustatic hypothesis is attractive, and by its aid some correlations at the lower levels—say, up to 650 ft or 200 metres—seem to be in sight, but at higher levels the possibility of tilting of the older surfaces must be borne in mind Prof Dudley Stamp, in one of his now rare utterances as a geologist, underlined this point and urged the growing band of younger British geomorphologists to supplement the record of their own observed stages of erosion by the depositional record provided by the late-Tertiary succession of Holland That record is one which implies warping or tilting of the areas to the west and south from which the deposited material came It was fitting that the last and youngest contributor to the discussion—Miss Alice Coleman—should announce that work she is completing in East Kent displays evidence in the uniclinal shifting of the Stour and, by the discrepancies in altitude between the Kentish succession of stillstands and those worked out for the South Downs by Mr B W Sparks, of eastward tilting during even the latest phases of landscape evolution

It is evident that in this field of common interest to geologists and geographers a good deal of work is being done, chiefly at the moment by the geographers, and that as the body of evidence derived from the field-work grows, it will demand for its proper interpretation the experience and imagination of some of the best minds in both subjects. This joint discussion made a not inauspicious beginning

D L LINTON

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# NEW DISCOVERIES OF THE AUSTRALOPITHECINÆ

IN 1946 there appeared a memoir of the Transvaal Museum by Dr R Broom and Dr G W H Schepers, in which were described the fossil remains of the Australopithecinæ discovered up to that date at Taungs, Sterkfontein and Kromdraai In 1947 Dr Broom, continuing his indefatigable search in the stalagmitic deposits at Sterkfontein, came upon a site which proved to be astonishingly rich in the remains of the Australopithecine group to which he had given the generic name *Plesianthropus* A further memoir* provides a description of these new discoveries The description, abundantly illustrated, is not intended to be more than a general account Indeed, there is now so much material available for study that some years are bound to elapse before it can all be subjected to a complete analysis Nevertheless, this preliminary account, brief though it is, will be welcomed by all those anatomists and palæontologists who are concerned with the problem of human evolution, for it has become abundantly clear that Dr Broom's discoveries are indeed very relevant to this problem A ground-plan of the new Sterkfontein locus in the memoir shows that it is of quite limited extent, covering an area of about forty-five square yards Within this restricted area have been found, closely packed together in the dense limestone matrix, the remains of eight skulls, three mandibles, portions of several limb bones (including a fine specimen of the pelvic skeleton) and very many teeth

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* Transvaal Museum Memoir No 4 Part 1 Further Evidence of the Structure of the Sterkfontein Ape-Man *Plesianthropus* Part 2 The Brain Casts of the recently discovered *Plesianthropus* Skulls By Robert Broom, J T Robinson and G W H Schepers Pp 117+8 pl (Pretoria Transvaal Museum, 1950)

All this new Australopithecine material greatly extends our knowledge of these extinct ape-like creatures and also (it is important to note) vindicates in a remarkable way the provisional conclusions which had already been expressed by Dr Broom and others on the basis of the earlier, more fragmentary, fossils Thus, the hominid characters of the auditory region noted in the original Kromdraai skull have also been demonstrated to be present in the new Sterkfontein skulls The hominid features of the occipital bone which had been observed in the Kromdraai skull and the type skull from Sterkfontein have been found to be consistently present in all the other skulls in which this region is preserved The reconstruction of the frontal region of the type skull of *Plesianthropus* has been verified by the practically complete skull (No 5) discovered at Sterkfontein in April 1947 The essentially hominid characters of the dentition are consistently repeated in all the newly discovered specimens of the teeth The earlier inference (based admittedly on rather incomplete material) that the Australopithecinæ were equipped with limbs approximating very closely to those characteristic of man has received striking confirmation from further discoveries of limb bones and of the pelvic skeleton

This last specimen deserves particular attention It was actually found *in situ* in the midst of all the other Australopithecine remains derived from the same locus (and at the same level) It consists of a practically complete right os innominatum and also a portion of the left side In the low broad ilium, the deep sciatic notch, the strongly developed anterior inferior iliac spine and a number of other features, the bone is essentially of the hominid type and (as Dr Broom's comparative illustrations demonstrate very effectively) contrasts very strongly with the pelvic bone of anthropoid apes Indeed, so human is the appearance of this bone, that some critics at first contended that it could not be part of an Australopithecine skeleton The circumstances of its discovery, however, appear to discount this criticism, as well as the fact that it presents unusual characters which (so far as is known) are not to be found in any variety of *Homo sapiens* It has further to be added that a second ilium of the same hominid type was later found at an independent site (Makapansgat) which had also yielded a mandible and portions of skulls of *Australopithecus*

Lastly, yet a third os innominatum, excellently preserved and reproducing the same features of the Sterkfontein pelvis, has now been discovered at Swartkrans The details of this fine specimen (which was also found *in situ*, within a few feet of two large Australopithecine mandibles) have not yet been published, but a photograph exhibited on behalf of Dr Broom and Mr J T Robinson at the International Anatomical Congress recently held at Oxford demonstrated very clearly its main features The fact that three specimens of the Australopithecine pelvis have now been found at these independent sites, and that they are all of a predominantly hominid type, leaves no further room for doubt that the posture of the Australopithecinæ must have approximated quite closely to that characteristic of the Hominidæ This evidence of the pelvis is consistent with that of the other limb bones the remains of which have been discovered by Dr Broom, and also with the less direct evidence provided by the basal region of the several skulls now available for study

Without doubt, the most important result of all the recent discoveries at Sterkfontein and elsewhere is that they eliminate any further need for relying for comparative or statistical study on single, isolated specimens which, it might be argued, are perhaps of an exceptional nature Attempts have already been made (somewhat prematurely, as it seems to me) to subject to statistical analysis some of the limited and very fragmentary Australopithecine fossils discovered several years ago, and certain inconclusive results (based on measurements taken at second hand or made on plaster casts) have unfortunately led to controversies which the much more abundant evidence since become available now show to have been unnecessary Thus, well over two hundred teeth of the Australopithecinæ have now been recovered, providing a much more reliable series for the study of variability than the first few specimens which have been used for this purpose The great accession of new material also makes it possible for the first time to compile satisfactory data regarding the degree of uniformity in the distribution of individual characters, or combinations of characters, in the Australopithecine population It can now be stated, for example, that nine out of nine palates consistently present evidence of a combination of hominid features in the upper dentition which has not been demonstrated to exist in any anthropoid ape even as an exceptional condition, that four out of four immature jaws with the milk dentition consistently show that the deciduous canines and first molars conform to the human (and not the ape) pattern, that more than a dozen specimens demonstrate that the permanent canines (presumably of both sexes) were consistently small and of human type and associated with no diastema, that seven out of seven anterior lower premolars show the non-sectorial bicuspid form distinctive of the hominid dentition, and so forth These are a few examples which could well be multiplied

Thus, it may now be accepted that, in the totality of their morphological features, the Australopithecinæ certainly resembled primitive hominids much more closely than do any of the known anthropoid apes The significance of this fact is, of course, open to interpretation Dr Broom and Mr Robinson express themselves carefully on this point, but they suggest (and the suggestion is one which seems best to fit the facts so far as these can be assessed at present) that the Australopithecinæ either represent a branch of the ancestral stock from which *Homo* was derived, or are at least rather closely related to this stock One of the outstanding features of the group is the small size of the brain (as indicated by the study of endocranial casts) There is reason to suppose, as Dr. Schepers points out, that the brain in relation to the size of the body may in some cases have been somewhat larger than that of the anthropoid apes of to-day, but the evidence of the Sterkfontein fossils evidently does not permit a firm statement on this point On the other hand, the more recent discoveries by Dr Broom of larger Australopithecine skulls at Swartkrans (photographs of which were also exhibited at the International Anatomical Congress) have raised anew the possibility that the size of the brain extended its range beyond that recorded for the gorilla and chimpanzee, and perhaps even came within the range of primitive hominids of the *Pithecanthropus* group

W E LE GROS CLARK

# QUALITY IN GRASSLAND

A DISCUSSION on "Quality in Grassland" in Section M (Agriculture) of the British Association, held on August 31 during the Birmingham meeting of the Association, was opened by Dr William Davies, director of the Grassland Research Station, Stratford-on-Avon His remarks were followed by a short paper presented by Dr D H Curnow, of the Courtauld Institute of Biochemistry, London, who dealt with œstrogens in grassland

Dr Davies suggested that rather than speak of quality in the singular, we should speak in the plural and discuss the 'qualities' of grass much as we speak of 'qualities' in man Although most people have a working knowledge of what is meant by quality or qualities, it is, however, extremely difficult to provide a clear and concise definition of either quality or qualities Among the qualities of grass and of grassland which were discussed were, first, the production of nutrients spread over as long a season of the year as possible, and the point was made that we here deal with quality as it is affected by high production of freely available nutrients Because of the concentration of digestible nutrients in the leaf, it is clear that one of the first qualities of good grassland is that it is leafy as well as being at high production over a prolonged season of the year Young actively-growing leaf is of better quality than leafage of slower growth, while it may be shown that leaf tip is of better quality than leaf base Actively growing leafage is usually of better quality than old and mature leafage Leaf lamina has qualities that are superior to leaf sheath (in the grasses) or petiole Stem even when immature is of lower quality than leaf

Evidence from current researches being conducted at the Grassland Research Station and elsewhere in Great Britain shows that herbage can be produced for consumption *in situ*, even in the middle of winter It is becoming clear, however, that winter grass has qualities which are distinctly different from those of spring-grown grass These differences may be associated with the high fibre content of winter grass and with a lower energy-value than similar grass grown in spring The nitrogen content of leaf lamina in winter is frequently higher than in summer The feeding of pasturage *in situ* during the winter, therefore, may mean that, in the case of the high-production animal, in any event, carbohydrate of low fibre and of high energy-value might well be the sensible supplement Indeed, there is some evidence to suggest that a carbohydrate supplement might be sensible, even at the height of spring flush

Grass, using the term as embracing the legume and the herb, as well as the true grasses, is the cheapest and probably the healthiest form of animal feeding-stuff, particularly when grazed *in situ* by the animal itself The farmer, therefore, is intensely interested in any technique which is practicable and will extend his grazing season Grazing out of doors during the wet and inclement weather of winter clearly creates new problems for the farmer, but none of these seems to be insoluble The work of the grassland technician is to examine critically the practical problems associated with the utilization of grass grazed *in situ* during the winter to provide the practising farmer with a technique both of production and of utilization of winter grass

It is by no means certain that fibre content, energy value and nitrogen-level in the dry matter are the only distinctive differences between summer and winter grasses Future investigation may indicate other differences, such as, for example, in œstrogen content or in the content of vitamin precursors, mineral value, and so on There is here a wide and largely uncharted field of study, not only for the agronomist and animal husbandryman, but also for the biochemist and veterinarian

It is a fairly simple observation that as grass, in its widest context, matures, so its quality deteriorates Every herbaceous plant goes through a period of maturation from the time it starts growth in spring to the time when it has produced flower and seed During this period the plant increases in dry weight but decreases in quality as measured by its nitrogen content (which gets lower) and its fibre content (which gets progressively higher) The farmer attempts to prevent this maturation taking its normal course when he grazes his grassland and maintains it in a leafy condition for as long as possible

The ruminant animal is the largest aggregate consumer of the grass crop It is abundantly clear that the animal at high production demands grass of high quality Grass, however, may not be the perfect food for animals at a high level of production, for it may well show deficiencies such as those to be associated with straightforward lack of energy-value The ruminant animal, however, can deal efficiently with leafage which may have a fibre content of 17 per cent or more The non-ruminant, on the other hand, such as the pig and the hen, may well be found to show ability to utilize the grass crop To do this effectively, and for grass to be a major element in its diet, we must provide herbage not only of high nitrogen content and of high energy-value but also especially herbage of low fibre-content Here we must set the problem not only to the agronomist but to the plant breeder also It should be possible for the plant breeder to select herbages in which the fibre content of the leaf lamina is as low as 10 per cent of the dry matter, and we should aim at material of even lower fibre content

Another aspect of quality in the grass crop is that relating to mineral content We know from the pioneer work of Prof T W Fagan and others that many of the herbs of our pastures are extremely rich in minerals, especially calcium, phosphoric acid and potash There may be other good attributes in the herbs when compared with the more normal grasses and clovers of Britain For example, many of the herbs are sought after by the grazing animal, and further, what is true of the major elements mentioned may also be true of the trace elements In this field, however, there is a great lack of critical evidence in so far as it relates to British herbage plants

One of the qualities of the grass/legume sward is that it seems to improve soil condition and is acknowledged to increase the fertility of the soil, or at least to promote some benefit whereby arable crops in the rotation become more thrifty and more productive. Here again there seems to be an extraordinary lack of sound experimental evidence. We can infer, however, with some degree of confidence that the farmer who has been able to introduce the long ley into his farming system achieves a soil which works easier and better, and he raises the general level of his crop yields. One of the good qualities to be looked for in the grass crop, therefore, is abundant root development, which in turn fosters an improvement in soil condition and in level of crop production. Much work is urgently required in this connexion, not only in the agronomic field but also in associated fields of scientific endeavour. We need to know, for example, the influence not only of different grasses, legumes and herbs upon soil fertility, but also the influence of different systems of management of the grass crop and the part they play in building up the soil. Similarly, what is the long-term influence of different mineral products upon the soil, as well as upon the crops that are grown?

No discussion on quality in grassland would be complete without reference to the qualities of the accepted fattening grassland of the Midlands and elsewhere in Great Britain. What is the fundamental difference between the so-called fattening and non-fattening land? Clearly, any land is capable of fattening a bullock if that bullock can be maintained at a uniform level and reasonably high plane of nutrition throughout its fattening period. In the case of fattening land, the accepted practice is to turn the cattle beast out to grass in April and, without any purposeful management, that animal may be expected to be fat soon after midsummer almost irrespective of weather or season. In the case of non-fattening land, however, to achieve the same result in the fattened animal, one needs to plan the grazing in such a way that the animal is moved from pasture to pasture and assured of an abundance of high-quality feed which will maintain the animal at a high level of nutrition. From the scientific point of view, therefore, the distinction between fattening and non-fattening land is not a fundamental one and is in no way absolute. If the fattening animal is kept at a constant high plane of nutrition during the whole of its fattening period, then it should be possible to fatten on any land in Great Britain.

Dr Curnow's paper on the œstrogens of grass was extremely informative. There is here clearly an important field of study which may have wide practical consequences. The technique of isolating the various œstrogenic compounds, and of relating each of them to the animal and its nutrition, remains to be worked out in detail. The observed facts are that, in Western Australia for example, excessive œstrogen occurring in a diet largely based on subterranean clover produced serious ill-effects in sheep of both sexes. Investigations in progress have shown that œstrogenic compounds are commonly found in a range of the native herbage of Great Britain, although normally not to the extent found in Western Australia. So far, little or no ill-effects have been observed in Britain, but work at the Courtauld Institute in London and at the National Institute for Research in Dairying at Reading is clearly important and aims in part at determining the role of the œstrogens in animal nutrition.

In the lively discussion which took place after the opening papers, Sir James Scott Watson indicated the practical difficulties of breeding in both the cow and the ewe so as to make use of the greater production which we can now expect from the grasslands of the world. This is a point of enormous importance, as it refers not only to our potential in lowland districts, but also to the problem of hill and marginal land. Dr Norman Wright indicated, however, that the need for more production from grassland in Britain is immediate, if only to reduce our annual requirements of imported feeding stuffs. If properly utilized, grasslands in Britain can provide the bulk, if not the whole, of our protein requirements for cattle foods, although we might have to import a certain proportion of low-fibre carbohydrates. Colonel J A Symon raised the important question of winter grass, and indicated that the problem on the farm is always to balance any extra summer carrying-capacity by an adequacy of good winter feed. Dr R E Slade suggested that our level of manuring in general practice is not nearly high enough, and that with an improvement in our manurial practice and an increase in the amount of plant foods applied to the soil our grasslands would produce not only more dry matter per acre, but also more leaf, and leaf of better quality. He drew the important distinction between leaf protein and seed protein. Prof H D Kay (president of Section M) closed the discussion by indicating that the animal protein factor might still prove a very important one, although speakers had suggested that a factor biologically equivalent to the animal protein factor may well be present in the leaf of high-quality herbage.

WILLIAM DAVIES

# PLANETARY ATMOSPHERES

A GEOPHYSICAL Discussion was held under the auspices of the Royal Astronomical Society during its recent visit to Dublin. Prof L W Pollak, of the Dublin Institute for Advanced Studies, presided, and the general subject considered was "Planetary Atmospheres", although, as will be seen, no very strict limitation to the problems discussed was really observed. Prof Pollak, in his opening remarks, directed attention to the fact that the occasion was perhaps a historic one, since it was, so far as he knew, the first time a meeting of this nature had been held in Dublin.

As a preliminary to the main discussion, Mr R Naismith, of the Radio Research Station, Slough, showed a research film entitled "The Ionosphere". The film illustrated the short-period changes in the heights and degrees of ionization of the various ionospheric layers, and showed clearly the great advantage of this method of presentation of scientific data in giving a coherent picture of comparatively slowly fluctuating phenomena.

The discussion proper was opened by Prof J H J Poole, who spoke on the origin of free oxygen in the earth's atmosphere. Prior to 1924, Jeffreys suggested that the constituents of the primitive atmosphere, including all the water of the hydrosphere, were originally held in solution in the once liquid earth, and only emitted to form an atmosphere during the final solidification of the crust. Harrison Brown's work on the terrestrial and cosmical abundances of the rare gases has recently confirmed this view It is highly improbable, as Jeffreys points out, that the gases emitted from the crust contained any free oxygen, but consisted mainly of water, carbon dioxide and nitrogen Three theories have been advanced to explain the subsequent production of free oxygen, namely (1) evolution of free oxygen from carbon dioxide by green plants during photosynthesis , (2) thermal dissociation of a small percentage of the dense water-vapour atmosphere present before the condensation of the ocean, and the subsequent escape of hydrogen into space due to the high atmospheric temperature (Tammann, 1924) , (3) photochemical dissociation of water-vapour by solar radiation in the upper layers of the atmosphere, and the escape of hydrogen due to the high temperature of these layers (J H J Poole, 1941 , P Harteck and J H D Jensen, 1948).

Prof Poole believes that while the bulk of the geochemical evidence shows that the main production of free oxygen was due to photosynthesis, it is necessary to assume that some free oxygen has been initially produced by a non-biological process to enable photosynthesis to start He then briefly discussed the other two proposed mechanisms It can be shown, if an isothermal atmosphere is assumed, that the period between the formation of the surface crust and the condensation of the ocean must have been very short, of the order of a few years This need not be considered to be a fundamental objection to Tammann's theory, since the escape of hydrogen at the assumed initial temperature of 1,200° C would be very rapid A more serious objection can be raised, however, to Tammann's tacit assumption that the temperature of the exosphere of the earth was comparable with that of its surface during this period Milankovitch, basing his argument on an equation due to Schwarzschild, has concluded that the original water-vapour atmosphere would have been in convective equilibrium, and consequently that when the surface temperature was 1,200° C , the earth was surrounded by a dense layer of clouds at a height of about 200 km and a temperature of about 100° C If this conclusion is correct, Tammann's theory must be invalid, since the rate of escape of hydrogen would be too slow Prof Poole considered that further investigation of this point is required, since Milankovitch's theory leads to the peculiar paradox that the hotter the surface of the earth was, the slower it cooled This is due to the fact that, as the earth cools, the cloud-level falls and the cloud-temperature increases, and therefore presumably the loss of heat by radiation increases

As regards the photochemical dissociation theory, the necessary conditions of high exospheric temperature and the presence of solar radiation of sufficiently short wave-length seem to be satisfied for the existing atmosphere The danger of concluding, however, that this would also be true for the primeval atmosphere, before the start of photosynthesis, was emphasized The temperature distribution above the tropopause is considered at present to be mainly due to the photochemistry of oxygen and the rarity of triatomic molecules, so that obviously conditions in an atmosphere consisting of carbon dioxide and nitrogen might be very different, and it seems probable that the exospheric temperature would be considerably lower To give any estimate of the rate of production of oxygen even in the present atmosphere seemed to Prof Poole to be impossible, owing to lack of knowledge of the amount of water present and the intensity of light of the requisite wave-lengths Jensen and Harteck have tackled this problem by calculating, on certain assumptions, the rate of diffusion of water-vapour into the *E*-layer, and assuming that this figure gives the rate of production of oxygen By this method they claim to have shown that the proposed mechanism could, in a period of 3,000 million years, have produced more than fifty times the existing amount of atmospheric oxygen This result, however, is perhaps doubtful, and possibly only gives a major limit

Prof Poole concluded by remarking that improved *V*2 rocket technique might enable us to test this theory by actual investigation of the concentration of hydrogen in the high levels of the atmosphere above, say, 150 km

Mr F Hoyle spoke on the origin of the lunar craters He maintained that, on recent cosmological theory, the moon during its early life must have suffered numerous collisions with meteorites, and that consequently the lunar craters must be due to these collisions If this deduction is true, the craters should be fairly uniformly distributed over the surface of the moon , but, as a matter of fact, certain areas of the moon, previously considered to be seas, have no craters T Gold has advanced a theory to explain this fact He considers that these areas are regions of low gravitational potential, corresponding to the ocean basins of the earth He then assumes that owing to the rapid changes of temperature of the moon's surface, very fine dust particles, of diameter about 100 A , are eroded from the higher levels of the moon These particles, under the combined action of attractive gravitational, and repulsive electric forces, tend to collect in areas of low gravitational potential, much as water on the earth collects in the ocean The consequence is that the so-called seas are really areas which are covered to a depth of perhaps four or five miles with a layer of dust effectively concealing the craters present beneath

Perhaps the most interesting contribution to the discussion was given by Dr D H Menzel, who spoke on the atmosphere of Mars He prefaced his remarks by expressing the hope that by making a strategic retreat to this planet, he might ensure for himself a fairly peaceful passage in the ensuing discussion Dr W Wright, of Lick Observatory, found, about twenty-five years ago, that photographs of Mars taken in ultra-violet light show practically no detail as compared with those taken in red light The diameter of the planet in the ultra-violet photographs also appears to be larger For many years astrophysicists have found difficulty in explaining this effect, since an atmosphere dense enough to obscure the centre of the planet's disk in the ultra-violet should scatter red light near the edge of the disk, where the effective depth of the atmosphere would be much greater Consequently, the ultra-violet and red images should be of equal diameter, and the central area of the planet should appear bluish in colour Dr Menzel stated that he pointed out this fact twenty-five years ago, and then doubted the reality of Wright's observations Despite his scepticism, however, he was afterwards admitted to Lick Observatory, and since then has become convinced of the validity of Wright's results He now attributes the larger ultra-violet image to a thin cloud layer of carbon dioxide crystals which exists at a height of about 100 km in the Martian atmosphere due to the temperature at this height being about 100° K. This layer would be capable of scattering ultra-violet light, but is transparent to red light, and thus accounts for Wright's observations

Dr Menzel then referred to the scarcity of water and the absence of oxygen in the Martian atmosphere He considers that the polar caps consist of a very thin layer of ice crystals, perhaps only a fraction of an inch thick During the long Martian summer the polar cap evaporates by sublimation without melting, and the actual surface temperature in the area of perpetual daylight may rise to about 20° C, the corresponding winter temperatures ranging from about $-30°$ C to $-90°$ C The atmosphere is usually very clear, but thin clouds have been observed to form in the late afternoon, and disappear during the early morning shortly after sunrise These clouds are probably composed of fine ice crystals An observer on Mars would see a deep blue sky with violet-coloured clouds forming at sunset

Dr Menzel concluded by referring briefly to the possibility of the existence of life on the planet He considers that while the existence of higher animal types of life similar to terrestrial forms is unlikely, it is possible, as G P Kuiper has previously noted, that some simpler forms of vegetation, such as lichens, may do so This would account for the seasonal change in colour observed in certain dark Martian surface features

Space can be found here for mention of only a few of the many interesting points raised by the subsequent speakers Dr E Opik considered that owing to infra-red absorption, the temperature of the carbon dioxide cirrus must be nearer that of the Martian surface (190° K) than the postulated 100° K required for its formation Dr Menzel agreed that this seemed an objection, but pointed out it might also apply to temperature problems in the earth's atmosphere Dr H H Poole and others raised the question of the possible origin of repulsive electric fields on the moon Friction between the dust particles and the moon's surface was suggested, but an attractive, not a repulsive, force would be produced in this way It was finally decided that a repulsive force could only be produced by both the particles and the moon's surface becoming positively charged through the emission of photo-electrons Several speakers doubted the meteoric theory of the formation of the craters on observational grounds, and also maintained that the seas present the appearance more of extensive basaltic lava flows, rather than of presumably featureless dust surfaces

Prof W M H Greaves raised the problem of the absence of free oxygen from other planetary atmospheres Prof Poole considered that for the major planets this is due to the fact that these planets have been able to retain hydrogen, and that for Mars and Venus it is caused by the absence of water Dr Menzel stated later, however, that he is not convinced that water does not occur on Venus, and he attributed the negative spectroscopic evidence to the occurrence of water as hail in a convective atmosphere He pointed out that Lyot's observations on the polarization of the light from Venus seems to indicate that the clouds are composed of water, and mentioned that further work on this problem is being undertaken at the Lick Observatory

Mr Hoyle considered that the absence of free oxygen in the original atmosphere would not prevent the formation of an ionosphere He further maintained that Tammann's theory must be rejected, because it would have supplied too much oxygen, and hence the theory really proved that no water was present in the original atmosphere, and that all the hydrogen contained in the existing oceans has been captured later by the earth from space, the oxygen required to form water being derived from the atmospheric carbon dioxide.

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# THE WORK OF THE MOTOR YACHT *MANIHINE*

By N. B. MARSHALL

Dept. of Zoology, British Museum (Natural History)

SINCE the summer of 1947, Major H W Hall, owner of the motor yacht *Manihine*, has placed this vessel at the frequent disposal of the British Museum (Natural History) for the purpose of marine biological investigations In British waters work has been almost entirely confined to the English Channel, more particularly to the lesser-known eastern half Besides adding to the national collections, these cruises over a period of four years have done much to increase our knowledge of the composition of the bottom fauna and summer plankton of the eastern Channel Samples of this plankton have been made available to the Marine Biological Laboratory at Plymouth, while from time to time work has been undertaken for the Fisheries Laboratory, Lowestoft

During the winter of 1948–49, the *Manihine* was concerned with a hydrological and biological survey of the little explored Gulf of Aqaba in the northern Red Sea Reports of this survey are now ready for publication It is planned to extend this work during the coming winter to the Sudanese Red Sea The biological work will mainly consist of routine plankton hauls, trawling and dredging (if the character of the sea floor permits), fishing by line and collections along the coral reefs As in the earlier survey of the Gulf of Aqaba, observations will be made on surface and sub-surface temperatures and salinities Records from a deep-water bathythermograph will also be taken

It may reasonably be expected that the results of the forthcoming work in the Sudanese area, together with those obtained earlier in the Gulf of Aqaba, will add considerably to our knowledge and understanding of the marine fauna of the Red Sea In particular, it is hoped to learn something of the nature and extent of the deep-water fauna, which is at present not well known There are, for example, records of only three species of bathypelagic fishes from the Red Sea How far the shallow sill at the southern end may act as a barrier to the immigration of bathypelagic forms has yet to be determined

It is the problem of barriers and the possible limitation of genetic interchange between Red Sea and Indian Ocean forms which makes a study of the fauna particularly interesting The Red Sea is, geologically speaking, a relatively young sea Its present connexion with the Indian Ocean, from which the greater part of its fauna has been derived, is thought to be about nine to ten million years old

To-day the entrance from the Indian Ocean is by way of the narrow Straits of Bab El-Mendeb, inside which lies a shallow sill having a maximum depth of about 100 metres Climatic conditions and the basin-like profile of the Red Sea are the predominating factors controlling the hydrological conditions, salinities and temperatures being generally higher than those in the Gulf of Aden, while, in contrast to the open ocean, there is no great difference of temperature between the surface and the bottom layers of water These physical features may well mean that the Red Sea fauna is (and has been) isolated to a considerable degree, this having favoured the evolution of new forms There are certainly good indications from earlier work and the survey in the Gulf of Aqaba that the Red Sea contains a considerable number of indigenous sub-species and species There is therefore the expectation that continued study of the fauna of the Red Sea and detailed comparison with that of the Indian Ocean will not only indicate something of the extent and direction of evolution but will also permit some correlation with the time factor

# OBITUARIES

## Sir Alexander Rodger, O.B.E

The death of Sir Alexander Rodger on September 30 last at the age of seventy-five brings to an end a fine career in the best traditions of forestry work

Rodger was educated at Blair Lodge School and from there passed into the Royal Engineering College, Coopers Hill, in 1895 He obtained a diploma in forestry three years later and went out to Burma, where he served until 1911 In the latter year he was appointed instructor at the Forest College, Dehra Dun, and forest economist in the new Research Institute which had been inaugurated by Lord Curzon in 1907 He returned to Burma in 1913, and during the First World War was deputy controller for timber supplies under the Munitions Board, having charge of the large shipments of timber that went from Rangoon for India and the Middle East He received the O B E in recognition of his good work

Rodger acted as conservator of forests in Tenasserim during 1920–22 and then was sent home in charge of the Burma exhibit to be erected at the British Empire Exhibition at Wembley As will be remembered, the Burma exhibit became one of the principle objects of interest at that great Exhibition

After some leave at home, Rodger returned to India as president of the Forest Research Institute and College at Dehra Dun early in 1925 In the following year he was appointed inspector-general of forests to the Government of India, this being the first time these two posts were held by one man As a result of the fine work done by the new Research Institute during the First World War, at its close the Government of India had sanctioned the construction of a very much larger Institute and new buildings, and these were opened by the Viceroy of India in November 1920, Rodger at that time receiving the honour of a knighthood

Among official publications for which he was responsible Rodger wrote "The Handbook of the Forest Products of Burma" and also undertook the publication of the second edition of Lace's "List of Trees and Shrubs of Burma" He retired from the Indian Forest Service in 1930 and served as a member of the Forestry Commission in Great Britain during 1932–39 and acted as external examiner in forestry at the University of Edinburgh during 1931–35

Rodger will be long remembered in Burma, as he did great work for the forests of that country, he will be equally well remembered at the Forest Institute at Dehra Dun, where his enthusiasm was an inspiration to all those who worked there with him and under him E P STEBBING

## Commander Vernon Edwards

VERNON EDWARDS died suddenly on September 22 at the age of fifty-nine He was educated at Weymouth College, where he distinguished himself at athletics, particularly at Rugby football, and, coming from an old naval family, was himself intended for the Navy However, he did not enter the Service until 1914, when he was gazetted a paymaster sub-lieutenant R N R and served with the Sixth Light Cruiser Squadron throughout the First World War in the North Sea and Mediterranean, and afterwards in the Baltic On demobilization Edwards found some difficulty in settling down in civilian life, and among other things he tried farming

By a fortunate chance, while staying with relatives in Sussex, he met the late Dr F A Bather, then keeper of geology in the British Museum (Natural History), who was much taken by the coloured toys, mostly animals, which Edwards made in his spare time Bather at this time had a scheme for making 'cut-out' restorations of extinct animals, mostly dinosaurs, for distribution to local museums, and Edwards was asked to carry out the work The scheme was not a very successful one from Dr Bather's point of view, but it started Edwards on his career From cut-outs of other people's restorations he quickly passed to original models of his own, and in these he was extremely successful for, although almost entirely self-taught both in art and anatomy, he had the remarkable gift of making 'dry bones live', at the same time taking the utmost pains to ensure accuracy The first models were mostly of dinosaurs and Tertiary mammals, but in 1931 he was asked to make a series of dioramas for the fossil fish gallery in the British Museum (Natural History) There were eight of these and they were most effective Thereafter dioramas and restoration-scenes became his chief work, while at the same time he extended his field to include historical subjects Apart from the large series of his palæontological works in the British Museum (Natural History) and the historical dioramas in the Tottenham Museum, examples of Edwards's work have been acquired by museums all over the world Recalled to the Navy in 1939, he served throughout the Second World War as Commander (S ) at sea in the North Sea and Mediterranean, and afterward, ashore in Ceylon, Mauritius and East Africa, but the heavy work put a great strain on him, and although he continued his modelling after the War he suffered from increasing ill-health

Edwards was a cheerful, generous, kindly man, without a trace of malice in his make-up, and he will be greatly missed by his friends in scientific and other circles He is survived by his wife and a married daughter E I W

# NEWS and VIEWS

## Scientific Council for Africa South of the Sahara

THE Scientific Council for Africa South of the Sahara, the functions and composition of which were approved at an inter-governmental meeting held in London last May, will meet on November 21 at Nairobi for discussions on the utilization of science for the benefit of the subcontinent The governments represented are Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa and the United Kingdom and Colonies The Council is constituted as follows Dr P J du Toit, president of the South African Council for Scientific and Industrial Research (*chairman*); Prof J Millot, director of the Scientific Institute, Madagascar (*vice-chairman*), Dr E B Worthington, scientific secretary to the East Africa High Commission (*secretary-general*), Prof Aubert, director of pedological research, Office of Overseas Scientific Research, Paris, Dr F J Cambournac, Institute of Tropical Medicine, Lisbon, Dr B A Keen, director of the East African Agriculture and Forestry Research Organisation, Nairobi, Dr J P Lebrun, secretary-general of the National Institute of Agricultural Research in the Belgian Congo, Dr A Mendes Correa, of the University of Oporto, director of the Higher Colonial College, Lisbon, and member of the Portuguese National Assembly, Prof T. Monod, director of the Institute of French Africa, Dakar, Col W H Mulligan, director of the West African Institute of Trypanosomiasis Research, Kaduna, Nigeria, Dr B F J Schonland, research professor of geophysics and director of the Bernard Price Institute, University of the Witwatersrand, Johannesburg, Mr N. P Sellick, director of research, Meteorological Services Salisbury, Southern Rhodesia, Dr L van den Berghe, director of the Institute for Scientific Research in the Belgian Congo The Council's functions will be to suggest new subjects for research and how to set about them, to link in friendly liaison (but not to supervise) scientific bureaux now working in this field, as well as individual research workers, to facilitate transfer of these workers from one territory to another, and the circulation of their reports, and to suggest, to the governments concerned, such specialist conferences as may advance the interests of Africa

## Presenting Science to the Layman

IT is very generally accepted that in the United States the art of successful popularization is well understood, not only of knowing how to catch the attention of the ordinary man, but also in the even more important sense of knowing how to apply scientific theories and methods to the problems that interest him and in ways which he can understand The July and August issues of the *Annals of the American Academy of Political and Social Sciences* (from the Academy Office, Philadelphia, 2 dollars each), dealing with the 'Point Four programme' and gambling, respectively, demonstrate this point very clearly Each of the issues is in the nature of a symposium, for which special editors are appointed, and each contains a wide variety of articles which deal with a subject of public importance from the more popular as well as a strictly scientific point of view The result cannot but be of great interest to the British reader, accustomed as he is to assume perhaps rather too readily that his own professional publications which deal with scientific topics cannot have more than an indirect effect on public opinion This method of analysing a problem, and of presenting the results, is best demonstrated by citing examples from these two issues of the *Annals* The discussion of the problem of gambling, for example, contains both a carefully prepared discussion of the psychodynamics of gambling, which is not likely to be understood by the ordinary reader, and also much more palatable articles, as, for example, that on gambling odds, prepared by a well-known statistician The issue which is concerned with the Point Four programme similarly deals with the political, psychological and economic aspects of American aid to underdeveloped countries from a strictly technical point of view, and also provides a summary of the implications of the scheme as seen by competent British and United States experts and others with more general interests

## Work of the Caribbean Commission

SOME of the activities of the Caribbean Commission, a consultative and advisory body to further and co-ordinate economic and social progress in those territories within its scope (including the British West Indies), were indicated by the Minister of State for the Colonies in a reply circulated in *Hansard* for May 24 The Technical Information Services answer technical inquiries over a wide field, as well as producing and circulating information leaflets, the "Yearbook of Caribbean Research", "Crops and Livestock Information", reports on plant and animal diseases and educational films Technical conferences have been held on land tenure, forestry, meteorology, livestock and soil science Surveys and studies have been made in plant and animal quarantine legislation, industrial development, the criteria for potential Caribbean industries, fishery population movements, and the utilization of sugar by-products Assistance in social and economic development has included aid to pioneer industries, tourist development and the administration of the war-time Caribbean schooner pool The Commission is also the parent body of the Caribbean Research Council and the West Indian Conference which meets once every two years Recommendations of the Conference which have been adopted by the Governments affected include the establishment of a Caribbean tourist committee, a meeting of meteorological experts in 1949 which led to improvements in the system of warning against hurricanes, and the grant to the Caribbean area, by the University of Puerto Rico of thirty scholarships to its School of Industrial Arts

## German Leather Industries during 1939–45

IN a comprehensive survey of "The Leather Manufacturing and Related Industries in Germany during the Period 1939–1945" (B I O S Surveys Report No 27, London H M Stationery Office, 1950, 3*s* 6*d* net), Dr C H Spiers has gathered together much valuable information from the reports of the various missions which investigated the German leather industries These reports do not disclose anything revolutionary as regards actual hide and skin processes, but they show some interesting chemical developments, notably the introduction of two fundamentally new tanning reactions ('immergan' and di-isocyanate tannages), an improved iron tannage ('ferrigan' tannage), the large-scale exploitation of the synthetic tannins, and the production of effective substitutes for natural oils and fats (derminols) A second sphere of development was in connexion with leather substitutes such as 'lefas', in which leather fibres are bound together by resin emulsions, or plastic soling materials made from polyvinyl chloride ('P'-soles) The production of sausage casings, artificial fibre and surgical sutures from skin pieces by the Naturin-Werk represents a remarkable piece of chemical engineering An important factor in the progress of the German leather industries has been the benefit which they have received from research and development in the German chemical industry, which systematically seeks new uses for the great variety of materials, intermediates, by-products and waste products which it produces The high standard of technical management in the leather industry secures that these developments are absorbed and applied by the industry

## The Wellcome Research Library

The Wellcome Foundation has given £80,000 to the Royal Society of Medicine in order to enlarge the accommodation of the Library of the Society, and to provide endowment for the purchase of books and periodicals from such of the capital of the gift as is not expended on the structural alterations and the equipment necessary to the enlargement The extension of the present Library is to be named 'The Wellcome Research Library' and it is left to the representatives of the Royal Society of Medicine in collaboration with the Wellcome Trustees to work out an application of the gift which shall preserve the conditions of the Trust and give the maximum effective benefit to the work of the Library of the Royal Society of Medicine This problem will clearly resolve itself into details of how best to provide the accommodation both for more readers in the Library as well as for the books, while increasing the efficiency of the extensive and complex library service of the Society, without impairing the working of the many other activities of the Society conducted in the building Enlargement of the House will be necessary, and the Trustees envisaged this in making the gift Plans have been prepared and are now under consideration.

## Adventure in Engineering

'Commemoration Day' at the Imperial College of Science and Technology, London, was observed on October 27 After an inter-denominational service at Holy Trinity Church, Prince Consort Road, the chairman of the governing body, Viscount Falmouth, the rector, Sir Roderic Hill, the deans, staff and students proceeded to the Great Hall of the Imperial Institute for the ceremony of presentation of diplomates Following the reception of the new diplomates of the Imperial College, and those of the Royal College of Science, the Royal School of Mines, and the City and Guilds of London Institute, and the presentation of scrolls to the honorary fellows elected during the past year, the 'distinguished visitor', Sir Bruce White, addressed the gathering Referring to his student days at the City and Guilds College, then known as the Central Technical College, Sir Bruce commented on the great improvement in facilities and equipment that had meantime been achieved However, despite wider and more intense studies, it seemed to him that engineers of the older generation would leave a deeper mark on the world than would those of to-day, they had vision and initiative which they did not fear to use Nowadays the incursion of politics into engineering is leading to domination by committees, so that whereas the successful discharge of responsibilities should be the highest aim of all engineers, initiative is in fact being curbed, and responsibility of the individual is escaped or denied Such a policy contributes to the astronomical cost of some public works to-day Sir Bruce White advised engineering students to dismiss from their minds the 'safety first' attitude, to scorn to achieve success by an excessive margin of safety, and readily to accept an opportunity of gaining experience abroad Experience should be sought in many fields of engineering practice, and to that end they should, while still young, be ready to move freely from one employment to another Life is ambition, and security should not be sought at an early age, ambition kept always before them would in due time find its outlet and fulfilment In the evening the laboratories and libraries of the Royal College of Science were open to visitors who, with the aid of senior students, were able to inspect and discuss the application of installations, instruments, and apparatus in current use in the teaching and research laboratories of the College

## Ophiuroidea of the Hawaiian Islands

Bulletin 195 of the Bernice P Bishop Museum, Honolulu ("Ophiuroidea of the Hawaiian Islands", pp 133, 1949), in which Austin H Clark describes new ophiuroid fauna, is the final report on the echinoderms collected by the United States Fisheries steamer *Albatross* in 1902 and makes a valuable addition to the knowledge of Pacific ophiuroids Besides the purely systematic description of Hawaiian ophiuroids, which includes the diagnoses of a number of new species, there is an interesting appendix on the general echinoderm fauna of the Hawaiian Islands In this the writer has analysed the shore catches from different islands as well as the offshore catches, which are recorded under station numbers The echinoderm fauna of the Hawaiian Islands lies on the periphery of the Indo-Pacific region, and some of the component echinoderms have become modified to form separate species Although the fauna shows a Japanese element, especially among the sea urchins, brittle-stars and crinoids, the writer points out that this does not constitute evidence pointing to a direct past faunal connexion between southern Japan and the Hawaiian area, the species common to these two regions may, in fact, have reached them by separate routes from the Indo-Pacific faunal centre

## Contributions to Embryology

Vol 33 of "Contributions to Embryology" maintains the very high standard which always characterizes this journal ("Contributions to Embryology", 33, Nos 213–221, Publication 583 Pp iii+186+34 plates Washington, D C Carnegie Institution, 1949 8 50 dollars) It comprises a series of papers on the reproductive organs, a series on embryology, and one anatomical paper by Adolph H Schultz on "The Palatine Ridges of Primates". The series on reproduction includes a monograph by S R M Reynolds on the changes which occur in the uterine vessels of pregnant rabbits, a paper by Elizabeth M Ramsey on the vessels of the endometrium in the pregnant rhesus monkey, and a short paper by S H Sturgis on the rate of follicular atresia in the ovaries of the rhesus monkey The most striking of the embryological papers is a monograph by Hertig and Rock on early human embryos In recent years these two authors have added almost as much to our knowledge of the earliest stages of man's development as have all previous workers put together Their present study deals with two human ova of the pre-villous stage, and whose ages are estimated to be about eight and nine days respectively Like their previous observations, this new study is bound to become text-book material Finally, the volume contains a review of the histogenesis of cartilage and bone, by the late Dr George L Streeter, formerly head of the Department of Embryology, Carnegie Institution of Washington, Baltimore, and to whose inspiration we largely owe the high standard of the journal in which this posthumous paper appears

## Electricity as an Aid to Productivity

A CONFERENCE on "Electricity as an Aid to Productivity", organised by the Institution of Electrical Engineers, will be held in the Lecture Theatre of the Institution during November 15–16 The conference is intended mainly for executives in both large and small factories who are responsible for production, including managers, production engineers and factory engineers, and will consist of a series of lectures on the following five topics motive power in the factory , industrial heating processes , welding applications , the handling and inspection of materials , lighting, heating, ventilation, etc The lectures have been planned from the point of view of the user, and will deal, in general terms, with what electricity can do to increase production rather than with technical details A report of the proceedings of the conference will be published later (price 6*s* ). Tickets for the conference can be obtained from the Secretary of the Institution of Electrical Engineers, Savoy Place, London, W C 2

## *Australian Journal of Applied Science*

THE first issue of a new quarterly journal, the *Australian Journal of Applied Science*, published by the Commonwealth Scientific and Industrial Research Organisation, appeared in March 1950 (1, No 1 , pp 132 , Melbourne Government Printer , 30*s* a year) It is intended as a medium for the publication of the results of original investigations in the broad field of applied science and is complementary to the *Australian Journal of Scientific Research* (A, Physical , B, Biological), *of Agriculture Research*, and *of Marine and Freshwater Research*, all three of which are published by the same Organisation The first number covers a wide field with ramifications into electrical technology, applied physics and chemistry, and the technology of timber There is a detailed study of the setting of synthetic resin and casein glues by means of the viscometer , very full data concerning the mechanical properties of red tulip oak, a tree abundant in Queensland , and an assessment of the value of various tannins, that can be extracted from Australian trees, for the production of adhesives by condensation with formaldehyde There is also an interesting account of the production of metal surfaces suitable for use as standards of roughness or surface finish , strips of chromium controlled in width, spacing and height are electrolytically deposited on the lapped surface of a steel block Improvements in the production of graticules by the use of metal films evaporated on to the glass surface are also described, and there is a series of five papers on the special treatments that must be applied to electrical equipment to prevent its rapid deterioration under tropical conditions These papers record a long series of investigations in which many organisations collaborated during the years 1943–46, and the most vital parts of the information are therefore already known to the radio industry It is, however, very useful to have a systematic and detailed survey easily accessible for reference Those who are interested in the physics and chemistry of water-repellent materials for the treatment of glass and ceramic insulators will find much new information in studies of the efficacy of quaternary ammonium as well as organo-silicon compounds used for this purpose The new *Journal* will be welcomed as an important contribution to the literature of applied science

## *Progress in Theoretical Physics*

ONE of the most remarkable things that came to light after the end of hostilities in 1945 was the emergence during the War of a vital and important school of theoretical physics in Japan It is so active that it has been able to found a journal devoted almost exclusively to theoretical physics, which must take its place on the shelves of any complete scientific library, side by side with other important learned journals *Progress in Theoretical Physics* (published by Akitaya Co , Ltd , Osaka, Kyoto, Japan) is edited by H Yukawa and printed in English It started publication in June 1946 , but unfortunately it has not, up to the present, been easy to obtain copies in Great Britain. The difficulties seem to be connected with export restrictions imposed by the occupying Powers. It is to be hoped that so important a journal will soon be readily available, and that an adequate stock of back numbers is in existence. The journal is mostly devoted to papers on the quantum theory of fields—as is natural in a country where physics is strongly influenced by the work of Yukawa and Tomonaga—but there are also papers on ferromagnetism and astrophysics in the early issues It contains many important papers , Tomonaga's classic paper on the covariant formulation of quantum field theories, for example, appeared in the second issue (August–September 1946), to be followed by developments of the idea in later papers The journal advertises itself on the inside cover as mainly concerned with papers on theoretical physics, which are related to quantum mechanics, statistical mechanics, the theory of relativity and the theory of elementary particles—showing that its editorial board is keenly aware of the direction in which vital advances are being made in physics Experimental papers intimately connected with contemporary theoretical physics are also eligible for inclusion

## *Educational Times*

THE *Educational Times*, which was first published in 1847, is now to become a digest of current educational literature and will be published three times a year, in February, June and October (from the College of Preceptors, 2 and 3 Bloomsbury Square, London, W C 1 1*s* ) This change has been brought about because it is felt that, with the present-day spate of periodicals dealing wholly or partly with educational topics, the difficulty of the teacher and interested layman is not that he has too little to read, but rather that he has too much and that it is so widely dispersed It is hoped, therefore, that the *Educational Times* in a new form, and with a new purpose, may satisfy the need of those who wish be in touch with current educational thought by providing them with summaries of articles and correspondence of outstanding educational interest which have appeared during preceding months in journals of English-speaking countries The first number (dated October 28) has been prepared by the dean of the College of Preceptors, Mr J H Simpson, and by the secretary of the College, Mr J V Chapman Subsequent issues will be edited by Mr Simpson with the assistance of Mr John Bosworth, a member of the College Council and a master at the Ashburton Secondary Modern School, Croydon

### *United Nations Documents Index*

THE first issue, dated January 1950, has been published of the *United Nations Documents Index: United Nations and Specialized Agencies Documents and Publications* (1, No 1, January 1950, pp 83, Lake Success, N Y United Nations, London H M Stationery Office, 7 50 dollars or 50*s* a year) This is a monthly publication and is intended to list and index by subjects all such material received by the United Nations Library, except restricted (confidential) material and internal papers Each issue will contain introductory material concerning sales, distribution and other pertinent items, a list of documents and publications of the United Nations arranged by symbol, followed by lists for each of the specialized agencies, and a subject index, which will be circulated annually The publication should become a useful work of reference for librarians, bibliographers and others

### Beckenham and Penge Grammar School: Scientific Society *Proceedings*

STILL further evidence of the growing interest in publishing scientific work carried out in schools has reached us in the above journal This is the second annual issue, the first was published in 1949 (price 1*s*) It is of interest to note that this School is a maintained grammar school attended by day pupils, and the papers published in the *Proceedings* record the work done by the boys out of their normal school hours F Weiss has been carrying out practical experiments investigating the inheritance of coat-colour in mice, and he records his results in two papers D J. Claringbull contributes a useful article on rearing butterflies, incorporating the results of his own activities Valuable training in team work is exemplified in the survey of a wood at Downe, Kent Here are recorded observations on the geological formation and nature of the soil (profile, analysis and temperature gradient), a tree census and a plant ecological survey The team was under the supervision of Mr F. H Brightman, and included the following boys R J McB Allan, M D Bass, C. Blyton, B G Bowes, P G Brand, G Doughty, P. George, D R Hills and A P Hughes Other papers published in this number are "Radish Fruits Variation in Length and Seed Number" by B Davis, D Holland and R Marriott, "A Model Gasworks" by A Chedzoy (the model set up by the author and K Felton and P Franks under the supervision of Mr A Thorne), "Sunspots" by N R B Hayes, B T Henry, D J Turner and G A Doughty, "A Wind Deflection Model" by M R Fry, "Meteorological Records" by M D Bass This journal is most praiseworthy, and reflects keenness and a true appreciation of scientific method and purpose at Beckenham and Penge Grammar School

### Agricultural Research Council Awards for 1950

THE Agricultural Research Council has announced the following awards for 1950 Junior agricultural research fellowships Dr C. Klatzkin (Department of Biochemistry, University College, London), for studies of changes in amino-acid contents of seeds during germination, and Dr H Ruben (Department of Genetics, University of Cambridge), for studies in the theory of genetics experimentation Research studentships and training grants *Botany Group*, J L Jinks, A D Kanarek, D J. C Friend, N R Lee, R E Parker, J McLeish, J S Cole, R A Lelliott and M J Dorey, *Entomology Group*, D R Ragge, C F Eastop, R D Winslow, Miss P M Harlow, B A Jones and Miss D Wedlake, *Chemistry Group*, P H T Beckett, R F W Goodwin, L D Finch, C Morgan, J H Fessler, D B Lindsay, Miss S M Wilson, G P Askew and D C Findlay, *Zoology Group*, K F Hosie, B Shaffer, Miss E Billing, J Bligh, M G Stokes, P N Wilson, K C Kirkham, M E Lancaster and A Durrant, *Veterinary Group*, J Thomas and A J S Campbell

### Faraday Society

SIR CHARLES GOODEVE has been elected president of the Faraday Society in succession to Sir John Lennard-Jones. Sir Alfred Egerton and Prof H W Melville have been elected vice-presidents in succession to the two retiring vice-presidents, Mr R P Bell and Sir Cyril Hinshelwood Profs C H Desch, F G Donnan, Allan Ferguson and M W Travers have been elected honorary life members of the Society, a new class of membership recently instituted to honour those of its members who have rendered outstanding services to the Society and to physical chemistry

### Mineralogical Society. Officers and Council, 1950–51

OFFICERS and Council for 1950–51 of the Mineralogical Society have been elected as follows *President*, Prof C E Tilley, *Vice-Presidents*, Dr A F Hallimond and Dr S J Chand, *Treasurer*, E H Beard, *General Secretary*, Dr G F Claringbull, *Foreign Secretary*, Dr L J Spencer, *Editor of the Journal*, Dr L J Spencer, *Ordinary Members of the Council*, Dr S O Agrell, H G Dines, G S Gowing, Dr S I Tomkeieff, Dr F A Bannister, Dr J Phemister, H M Powell, H P Rooksby, G E Howling, P A Sabine, Dr F H Stewart and Dr A K Wells

### Announcements

A COLLOQUIUM on sensitive emulsions and their physical and physico-chemical properties will be held in Paris during September 24–29, 1951 The principal topics to be discussed are physico-chemical properties of the halogen compounds of silver, sensitivity of emulsions and optical sensitization, development, and emulsions for nuclear work Papers for the colloquium should be submitted before June 1 Further details may be obtained from Mme A T Vassy, Faculté des Sciences de Paris, 1 rue Victor Cousin, Paris 5$^e$.

MR FRANK GAYNOR has directed attention to an error in the review of his book, "A Pocket Encyclopedia of Atomic Energy", which appeared in *Nature* of August 26, p 326 It is there stated that Mr Gaynor does not mention the well-known table of isotopes by Seaborg and Perlman, whereas in fact a reference to this paper appears in the text on page 81 This reference was overlooked by the reviewer, who regrets the omission

# CYTOLOGY, GENETICS AND CLASSIFICATION

AN all-day discussion on September 4 on "Cytology and Genetics in Relation to the Classification of Plants and Animals" was arranged by Sections D (Zoology) and K (Botany) of the British Association during the Birmingham meeting The morning session dealt mainly with animal organisms and the afternoon session with plants

Mr S Muldal (John Innes Horticultural Institution) opened the morning discussion with a general paper on earthworm cytology The British earthworm fauna comprises the genera *Allolobophora* (five species), *Lumbricus* (five), *Eisenia* (three), *Eiseniella* (one), *Dendrobœna* (four), *Bimastus* (four), *Octolasium* (two) and *Eophila* (one) There are generic differences with regard to cocoon production by unmated worms, there being species with no cocoon production (*Allolobophora*), infertile only (*Lumbricus*), and fertile cocoons (in most other genera) It appears that the mode of reproduction varies from the strictly cross-breeding species such as the British *Allolobophora* and *Lumbricus* species to the obligate parthenogenetic *Octolasium cyaneum* ($8x$), *Eiseniella tetrœdra* ($4x$), *Eisenia rosea* ($3x$) and *Bimastus tenuis* ($3x$) The chromosome number is constant in *Lumbricus*, $n = 18$, which is probably the primitive basic number for the family In *Allolobophora* there are two basic numbers, 18 and 16 In *Dendrobœna* the basic number is 17, in *Bimastus* 16, in *Octolasium* 19, in *Eisenia* 11 and 18, and the subspecies examined of *Eiseniella tetrœdra* have $2n = 72$, with 18 as probable basic number The latter have probably developed from the polymorphic *Eisenia venata*

All the polyploid worms show obligate parthenogenesis They are highly successful species, peregrine and cosmopolitan, and exhibit less variation than do the sexual species It is a general belief, Mr Muldal said, that polyploidy is very rare in the animal kingdom, but at the moment we have little evidence on which to base this assumption Large groups of animals are still not examined, and the numbers included in the chromosome lists are often from widely separated species Only by working through relatively young animal families, like the Lumbricidæ, can one assess the part played by polyploidization in speciation Old polyploidy, from a phylogenetic point of view, is, however, often impossible to discover in our present animals, since older types with lower multiples may be altogether extinct

Dr B N Singh (Rothamsted Experimental Station) has studied nuclear division in small free-living amœbæ and its bearing on their classification The free-living amœbæ have previously been classified largely on the basis of nuclear structure and mode of division Extraordinary differences in the behaviour of the nuclear constituents have been claimed, and the consequent confusion has been due to two principal causes the difficulty of getting the various normal stages of nuclear division, owing to lack of suitable cultural conditions , and the use of Hæmatoxylin or other non-specific dyes for showing the nuclear structure and behaviour A detailed study of the effect of varied bacterial food has led to the development of a standard culture method This enables one to get all the stages of division in young and healthy specimens The division of twelve strains of amœbæ, consisting of at least nine distinct species, has been studied

The use of the Feulgen reaction has shown that the resting nucleus of all the species contains Feulgen-positive granules, which give rise to chromosomes during division The karyosome (nucleolus) does not contain Feulgen-positive chromatin, nor does it give rise to chromatin at any stage This brings the mode of nuclear division in line with that in higher animals and plants

According to their mode of division the amœbæ can be arranged in two groups In one, the karyosome persists throughout division, whereas in the other it disappears Such a diversity was not apparent in the earlier works

The next contribution to the discussion was a paper read by Mr L Sachs (School of Agriculture, Cambridge) on cytogenetics in relation to the systemation and phylogeny of the Triticinæ

The Triticinæ (Gramineæ) contains the genera *Aegilops*, *Agropyron*, *Haynaldia*, *Secale* and *Triticum*, with a total of well over a hundred species In a comparison of the different methods of investigating the systematics and phylogeny the following modes of approach were discussed and illustrated gross morphology, chromosome number and morphology, chromosome pairing and fertility in interspecific and intergeneric hybrids, chromosome pairing and fertility in colchicine-derived amphidiploids, the genetic behaviour of certain characters, and the attempted artificial synthesis of existing species

In the analysis of chromosome pairing in hybrids, Mr Sachs discussed the genome concept, and evidence was presented to show the desirability of revising the accepted genome formula for the tetraploid species *Triticum timopheevi* In the discussion on interspecific and intergeneric amphidiploids, it was also suggested that, although some of these are morphologically distinct and reproductively isolated new 'species' or even new 'genera', they should not be given new specific or generic names, but rather formulæ in order to show their experimental origin The methods of comparative genetics were illustrated by the action of interspecific and intergeneric lethals and sublethals associated with a hexaploid species of *Triticum.* Each of the five genera has evolved in its own way, either by instantaneous speciation brought about by polyploidy or the presence of interspecific lethals, or by gradual speciation brought about by accumulation of gene and chromosome changes

The last speaker was Dr J P Harding (British Museum (Natural History) ), who gave a review of the cytology of some Crustacea as an aid to their classification He said that consideration of the chromosome numbers of copepods indicates that the more primitive members have the highest numbers. The Calanoida is the most primitive sub-order and the haploid number is nearly always 16 or 17, whereas in the other sub-orders it is rarely more than 12 and may be as low as 2 In Cyclopoida also the highest numbers are found in the more primitive species.

Three closely related species, *Cyclops fuscus*, *C albidus* and *C distinctus*, occur in Great Britain, often in the same body of water *C distinctus* is on the whole intermediate between the other two both in its morphology and in its ecological preferences, and many workers have considered it to be a hybrid between them. In both *fuscus* and *albidus*, seven bivalents are found in the oocyte, those of *albidus* being distinctly smaller than those of *fuscus*. In *distinctus* the chromosome number is variable, which indicates its hybrid nature. Breeding experiments do not give direct support to this, for the three forms breed true and are completely intersterile. *C. distinctus* seems to be a good species of hybrid origin.

Closely related species of *Cyclops* may have different chromosome numbers. *C. vernalis*, *C. parcus* and *C. brevispinosus* are so similar that most systematists make no attempt to separate them; their haploid numbers are, however, 5, 3 and 2 respectively.

The true nature of breeding systems can in most cases be assessed only by cytological study, and their determination is a decisive step in working out the systematics of a group. The chromosome number is also an additional morphological characteristic of which too little use has been made so far. The discoveries made with the aid of these newer tools will be of great importance in revising the 'old systematics'.

S. MULDAL

THE first speaker at the afternoon session was Prof. T. J. Jenkin, who described his extensive experimental work on the grass genera, *Lolium* and *Festuca*. Two groups of species, all diploid ($2n=14$), can be distinguished in *Lolium*: one, which is self-pollinated, comprises *L. temulentum*, *L. remotum* and *L. loliaceum*; and the other, which is cross-pollinated, *L. perenne*, *L. rigidum* and *L. italicum*. Within each group more or less fertile interspecific hybrids can be made, and viable hybrids can also be made between members of each group. Among factors which may have been responsible for speciation, involuntary human selection for seed size in *L. temulentum*, a weed of cereals, and in *L. remotum*, a weed of flax, was mentioned as an interesting possibility. *Festuca* is a larger and more widely distributed genus, and contains polyploid as well as diploid species; two groups, narrow-leaved forms such as *F. capillata* ($2n=14$), *F. ovina* ($2n=28$) and *F. rubra* ($2n=42$) and broad-leaved forms such as *F. pratensis* ($2n=14$), *F. arundinacea* ($2n=42$) and *F. gigantea* ($2n=42$), can be distinguished. Again, hybridization within each group is possible, though the hybrids are often male-sterile; but the only hybrid linking the two groups directly is *F. rubra* × *F. arundinacea*, which is weak vegetatively and has never flowered. An indirect link is provided through *Lolium perenne* and *L. loliaceum*, both of which have been successfully crossed with both groups of fescues. These experiments, and the cytological investigations which have been made on the hybrids, clearly have an important bearing on the taxonomy and phylogeny of the genera.

Colonel F. C. Stern, who spoke next, gave several examples of the uses of chromosome number and morphology in solving taxonomic problems; he illustrated his remarks by means of excellent maps. First, in the genus *Pæonia*, the European members can be divided into groups, each containing diploid and tetraploid species. Not only do the chromosome numbers here form an invaluable guide to the taxonomist in distinguishing closely allied forms, such as *P. Cambessedesii* (Balearic Is., $2n=10$) and *P. Russi* var. *leiocarpa* (Corsica, $2n=20$), but they also provide a clue to the phylogeny of the group; it is likely that the diploid forms are the isolated relics of preglacial populations, and that the tetraploids, with their wider and more continuous distribution, have developed in inter- and post-glacial times. Secondly, in *Primula* section *Farinosæ*, subsection Eu-farinosæ, chromosome counts facilitate the distinction of species otherwise almost indistinguishable morphologically, such as *P. scotica* ($2n=54$) and *P. scandinavica* ($2n=72$), and also give an illuminating guide to the relationships of the many polyploid species. The possibility that the circumpolar *P. stricta*, with 126 chromosomes, is an allopolyploid derived from species with 54 and 72 chromosomes, was mentioned. Thirdly, the chromosome number and morphology of the genera *Galanthus* and *Leucojum* were discussed; in *Leucojum* the basic numbers $n=7$, 8, 9 and 11 are known and most of the species are found at the western end of the Mediterranean. In *Galanthus*, practically all the species have $n=12$, and most of the species are found at the eastern end of the Mediterranean and in the Caucasus. It was suggested that the two genera had both been derived from an ancestral European stock that had been split into two parts as a result of glaciation; in this connexion, the close resemblance between *Leucojum vernum* ($n=11$) and species of *Galanthus* was pointed out. It was also shown that breakage or fusion of chromosomes, as in *Fritillaria*, may have been an important factor in species-formation in *Leucojum*. Finally, examples were given of the use of cytology in tracing phylogenetic lines (in *Crepis*) and in deciding between alternative taxonomic arrangements (*Yucca* and *Agave*).

The correlation between morphology, chromosome number and geographical distribution was further developed in the next paper, by Dr. E. K. Janaki-Ammal, on polyploidy in the genus *Rhododendron*. After referring to the early work of Sax, who had suggested that this genus consisted mainly of diploids, with $2n=26$, Dr. Janaki-Ammal described her own recent investigations, which have covered the forty-three sections into which Hutchinson has divided the eight hundred species of the genus. The cytological results can conveniently be summarized under three main groups. First, the *Azalea* group, with a wide distribution in the northern hemisphere, is diploid except for two tetraploid species in North America. Secondly, the non-lepidote group, comprising among others the well-known tree rhododendrons of our gardens, is exclusively diploid; 146 species of this group, which is found mainly in Eastern Asia, have been examined. Thirdly, the lepidote group, composed mainly of montane Himalayan species, contains a very high proportion of polyploids, with chromosome numbers ranging from 52 to 156. The interesting point was made that the circumpolar *R. lapponicum* is always diploid, while its Himalayan relatives are polyploid. These new observations will obviously contribute very greatly to our understanding of the genus *Rhododendron*.

In the fourth paper, Prof. D. H. Valentine spoke about the use of interspecific compatibility as a taxonomic criterion. He began by defining the 'comparium', which is a group composed of all those species which can be united, directly or indirectly, by hybridization; this unit, which was first proposed by Danser in 1929, is useful because it can be fairly precisely defined, and is of a size comparable with the genus or subgenus. In *Primula* section *Vernales*, in *Epilobium* section *Chamænerion*, in *Viola* sections *Nominium*, *Dischidium*, *Chamæmelanium* and *Melanium*, and in *Pæonia*, sections *Moutan* and *Pæon*, the comparium agrees well with the subgenus, section or subsection, and, where it disagrees, it provides useful suggestions for taxonomic revision. On the other hand, it is useless in genera such as *Lathyrus*, in which attempts to obtain interspecific hybrids have failed. It is interesting to note that in some families, for example, the Gramineæ, a single comparium may comprise many genera, such as *Lolium–Festuca*, and *Triticum–Aegilops–Agropyron–Secale–Elymus*.

In order to analyse relationships within or between comparia, it was suggested that variation in what may be called seed compatibility, that is, the ability to form hybrid embryo, seed and seedling, could be used. Examples were given from the genus *Viola* at the sectional-level, and from *Primula*, section *Vernales*, at the specific-level. In the latter, evidence from both seed compatibility and hybrid fertility agrees in placing *P. elatior* closer to *P. vulgaris* than to *P. veris*. Application of this criterion to outbreeding diploid groups (gradual ecospecies) similar to the *Vernales*, for example, portions of the genera *Rhododendron*, *Lolium*, *Quercus* and *Epilobium*, were suggested. It was pointed out, however, that the hypothesis on which this application is based, namely, that degree of seed compatibility is proportional to taxonomic relationship, is clearly incorrect where the relation between diploid and tetraploid species is concerned. Here, analysis shows that comparable pairs of closely allied diploid and tetraploid species may vary enormously in seed compatibility. Thus, they may be completely intercompatible, as in *Viola riviniana* ($n = 20$) × *V. reichenbachiana* ($n = 10$), completely incompatible, as in *Galeopsis tetrahit* ($n = 16$) × *G. speciosa* ($n = 8$) or, most commonly, as in *Nasturtium microphyllum* ($n = 32$) × *N. officinale* ($n = 16$), partially compatible.

In the general discussion which followed, Prof. Jenkin described some interesting results on seed compatibility in *Lolium*, and Dr. Turrill briefly reported some unpublished work of Mr. E. M. Marsden-Jones on *Anagallis*. The numerous colour forms of *A. arvensis* are all intercompatible and interfertile, but only a single one, out of more than thirty that are known, can be crossed with the related species *A. femina*. The reasons for this remarkable limitation of compatibility are as yet unknown.

D. H. VALENTINE

# CHEMISTRY OF THE CELL AND ITS NUCLEUS

A DISCUSSION on 'The Chemistry of the Cell with Special Reference to the Nucleus", arranged by Section K (Botany) of the British Association at the Birmingham meeting, took place before a large audience on September 1 under the chairmanship of Prof. K. Mather.

Prof. M. Stacey (University of Birmingham) opened the discussion with a paper on the chemical composition of some cell nucleoproteins. He dealt first with the chemistry of deoxypentose nucleic acids and pentosenucleic acids, indicating that these must now be regarded as two distinct groups of nucleic acid, with quite marked differences in physical and chemical structures between products from different cells. Although the deoxypentose type is found mainly in nucleal structures and the pentose type mainly in cytoplasmic material, it is becoming evident that at different stages of cell-growth—especially in bacteria—there is a good deal of overlap in the location of the two groups of nucleic acid. The nucleic acids are found in firm combination with various types of protein, and methods for their separation were outlined. The basic proteins in chromosomes are more complex than was thought by earlier investigators. The present position was then outlined of the magnesium ribonucleoprotein which forms the dye-retaining part of the surface structure of Gram-positive micro-organisms, and the new observation was made that only a small part of the ribonucleic acid of various cells is bound in the Gram complex. The behaviour of the nucleal proteins under the influence of cell 'autolytic' enzymes, especially the nucleases, was also discussed.

Dr. W. G. Overend dealt with work at Birmingham on the fundamental chemistry of the Feulgen and Dische reactions for cell nucleal material. He explained the need for knowing what takes place during cytological staining practice, particularly in regard to the nucleal components. The Dische reaction is primarily concerned with the deoxyribose in the chromosome nucleic acid, and it is seen as a blue stain when diphenylamine is added to the cellular material previously treated briefly with acetic and sulphuric acids. Studies on a wide variety of unusual carbohydrates, using spectrographic techniques, show that it is given by 2-deoxy pentoses and by furfuryl alcohol. These under acid conditions are finally converted into lævulic acid, which gives no colour with the reagent. It was shown that an intermediate substance in the conversion, namely, ω-hydroxylævulic aldehyde, is the actual compound giving the dye with diphenylamine. Other compounds such as deoxyxyloses, which can be converted into this aldehyde, can give the Dische diphenylamine reaction, which is therefore relatively non-specific, and caution must be used in interpreting the results of the test. Protein breakdown products also influence the amount of colour produced.

The Feulgen reaction, which has been so valuable in locating nucleal structures, consists in the action of Schiff's aldehyde reagent on acid-treated cells to give a magenta colour. It depends on the fact that in deoxypentosenucleic acid the deoxy sugar occurs in the furanose or 5-atom ring form, and under acid conditions the ring opens readily to give a relatively high proportion of the open-chain form, which gives the aldehyde reaction. Model substances having different ring forms of different normal and deoxy sugars illustrate this point. In cells the aldehydo sugar is still attached to the purine and pyrimidine bases in the nucleoprotein, and the complex dye is therefore non-diffusible and locates precisely the nucleic acids. It was clear from Dr. Overend's remarks, however, how the action of lytic enzymes or over-hydrolysis by acids can give discrepancies in application of the reaction.

Mr. F. L. La Cour next discussed some aspects of his work at the John Innes Horticultural Institution on heterochromatin in plants. He explained briefly that the term 'heterochromatin' has been used to define specific chromosome segments which remain heavily stained and condensed at certain phases of the nucleal cycle. Heterochromatin is attached to the histone type of protein, whereas euchromatin is attached to more basic proteins. The amount of heterochromatin at various stages probably depends on competition with the euchromatin. The heterochromatin can be made particularly visible at metaphase by working at relatively low temperatures, for example, at +5°, especially in cells from root tips. Using the method of working 'in the cold', Mr La Cour has obtained a variety of results which he showed by micrographs and by numerous striking diagrams. In some plant species the chromosome segments are well defined, whereas in others they are either absent or the genes composing them are too minute to show up. Significant results have been obtained with various species of *Fritillaria* obtained from both the New and the Old Worlds. In some of the New World species heterochromatin is absent. The heterochromatin maps clearly enable one to detect species and give information on hybridity. Heterochromatin is probably concerned with the transfer of gene products to the cytoplasm.

In the final paper of the session, Mr I. Leslie described recent work of the Biochemistry Department of the University of Glasgow on the role of the cell nucleus in the biochemistry of tissue growth. Based on Vendrely's postulate that the nucleus is a constant chemical entity in the cell, Mr Leslie and his colleagues selected deoxyribonucleic acid as a constant measurable component (by phosphorus analysis) of the nucleus and are able to express results as increases in actual cell number and as variations in amounts per cell of the other cell components. This method gives a new and easily applied method of measuring growth, which is superior to methods based on measurement of changes of concentration per unit weight.

The deoxyribonucleic acid content per nucleus varies with the pathological conditions; for example, in fowl sarcoma the unit is 2.8 instead of the normal 1.4. Special applications of the analytical technique were then described. With the roller-tube tissue-culture methods under aseptic conditions, it is possible to measure the changes in number of cells with time up to a maximum in a period of 96 hr and to correlate these figures with increases in protein, phospholipid components, etc. Between 0 and 48 hr the proteins and phospholipids increase most rapidly and are synthesized mainly before the deoxyribonucleic acid, and before cell division occurs. On the other hand, the ribonucleic acid content was shown to be greatest during cell multiplication. Some clearly marked changes are seen in the developing chick embryo, the most striking being the remarkable increase in muscle protein and acid-soluble phosphorus at the eighteenth day—presumably for the chick's purpose of extricating itself from the shell. Medical aspects in health and disease were then described, notably concerning glucuronidase in rat liver and for following changes in bone marrow components and in leukæmia and pernicious anæmia.

In the latter disease, there is a markedly higher content of deoxyribonucleic acid when double sets of chromosomes are seen and later the cells fail to divide. In chemically induced tumours and other abnormal growth cells, the failure to synthesize proteins can be seen in a clear fashion.

M. STACEY

# VIBRATIONAL STUDY OF THE WOOD USED FOR THE SOUND BOARDS OF PIANOS

By EIICHI FUKADA

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I HAVE measured the dynamic Young's modulus and the logarithmic decrement of spruce (in Japanese, *Kuroezomatsu*) which is used for the sound board of the piano; and I have investigated the difference in these physical quantities between suitable woods for sound boards and unsuitable ones, as chosen by the piano maker by experience.

The method of experiment[1] was the lateral vibration of a plate about 30 cm long, 2 cm wide and 0.3 cm thick. The Young's moduli were determined from the resonant frequencies of this sample. The logarithmic decrements were determined by measuring the total charge of the rectified damped electric current which was caused in the pick-up by the damped oscillation of the sample.

Suitable materials had widths of annual rings of about 1–2 mm.; unsuitable materials had rather large annual rings (about 3 mm.). Two or three pieces of so-called red wood and rotted wood respectively were used. The fibres were orientated in the direction of length of the plate. Discrimination was easy by observing the appearance. The red wood is usually found in the lower part of the tree trunk. It is rather red coloured, hard and readily distorted. Rotted wood is wood which has begun to decompose.

Some of my results are shown in the accompanying graphs. Summarizing, I conclude that Young's modulus is higher for the suitable wood than for the unsuitable material, and that the logarithmic decre-

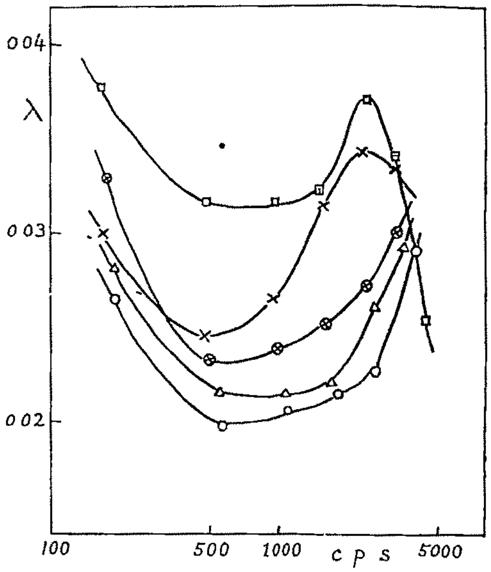

Fig. 1. Comparison of logarithmic decrement of suitable and unsuitable woods

○, 2-mm. annual ring, $E = 1.22 \times 10^{11}$ dynes/cm.²
△, 1-mm. annual ring, $E = 1.18 \times 10^{11}$ dynes/cm.²
⊕, larger width of annual ring. $E = 1.20 \times 10^{11}$ dynes/cm.²
×, rotted wood, $E = 0.8 \times 10^{11}$ dynes/cm.²
□, red wood, $E = 1.0 \times 10^{11}$ dynes/cm.²

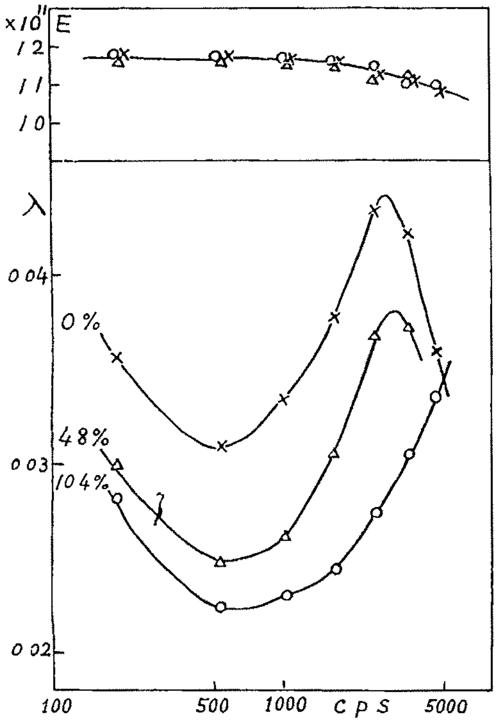

Fig 2 Effect of moisture content

ment is smaller for the suitable material and larger for the unsuitable one The unsuitable material with width of annual ring of about 3 mm shows the same value of Young's modulus but a little larger decrement compared with the suitable one In the case of both red wood and rotted wood, the maximum logarithmic decrement was found at a frequency of about 2,000–3,000 c p s Suitable material will probably show such a maximum at the frequency of about 5,000–6,000 c p s These frequency ranges could not be measured with the present apparatus In any event, suitable wood has the larger Young's modulus and the smaller decrement

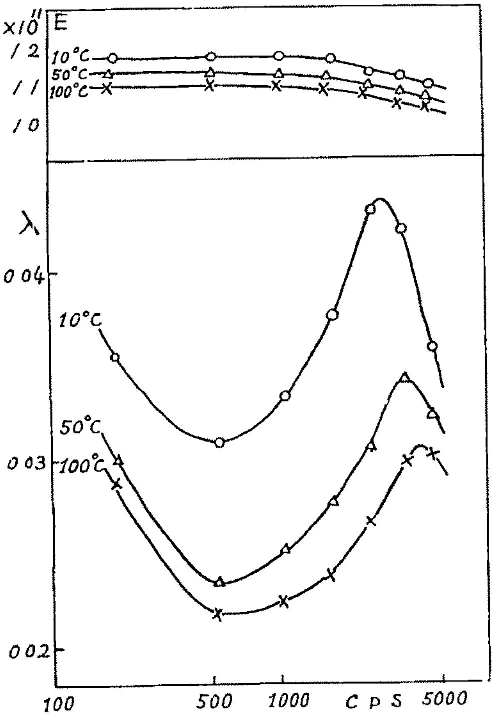

Fig 3 Effect of temperature in the absolutely dry state

The frequency character of the logarithmic decrement varies considerably with the moisture content and the temperature One example for a suitable wood is given in Fig 2 Young's modulus shows no change for moisture contents of 10 4, 4 8 and 0 0 per cent respectively The decrement increases as drying and the maximum frequency becomes smaller In the absolutely dried state the variation due to the temperature of measurement is seen in Fig 3 Young's modulus decreases with temperature Decrement also decreases with temperature and the maximum frequency becomes larger This behaviour of decrement with frequency is very common in many woods other than spruce It suggests there is some relaxation phenomenon in the structure of wood causing such a maximum decrement It will be discussed fully elsewhere

I wish to express my thanks to Dr Heiji Kawai for his guidance and encouragement throughout this work [March 28

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# PROTECTION OF ENZYMES BY ANTICHOLINE-OXIDASES AGAINST INACTIVATION BY NITROGEN MUSTARD

By J S COLTER* and Prof J. H QUASTEL, F R S

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THE nitrogen mustards have excited considerable interest in recent years because of their use as therapeutic agents in Hodgkin's disease, lymphosarcoma and leukæmia[1,2,3,4,5,6] It is obviously of interest to discover the mode of action of the nitrogen mustards in bringing about their cytotoxic effects, particularly if such investigations would lead to the formulation, or discovery, of substances having greater specificity of action on tumours and less toxic action on the host tissue One useful line of inquiry is the investigation of the toxic action of nitrogen mustards on enzyme systems, and of the chemical nature of substances that might enhance or inhibit this effect

In spite of the high degree of reactivity of the nitrogen mustards in aqueous, weakly alkaline solutions, which would lead one to suppose that they would be powerful inhibitors of a large number of enzyme systems, the investigations of numerous workers have demonstrated that this is not the case Barron, Bartlett and Miller[7] have shown, however, that choline oxidase and the choline acetylase system are strongly inhibited by the nitrogen mustards, and have confirmed the findings of Thompson[8] and of Adams and Thompson[9] that acetyl choline esterase is similarly strongly inhibited by these poisons

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Table 1. Protection of choline oxidase against the toxic action of nitrogen mustard Choline oxidase activity examined anaerobically by the ferricyanide technique[10 11]

| Protector molecule (P) | Molar concentration of P | Molar concentration of nitrogen mustard | Incubation time Min | Percentage inhibition of choline oxidase | | Percentage protection by P against nitrogen mustard |
|---|---|---|---|---|---|---|
| | | | | In presence of P | In absence of P | |
| Ammonium ion | 0 15 | $10^{-4}$ | 30 | 63 | 97 | 35 |
| Methylamine | 0 05 | $10^{-4}$ | 15 | 3 8 | 78 4 | 95 |
| Methylamine | 0 025 | $10^{-4}$ | 15 | 16 0 | 54 5 | 71 |
| Dimethylamine | 0 05 | $10^{-4}$ | 15 | 6 9 | 69 0 | 90 |
| Ethanolamine | 0 05 | $10^{-4}$ | 15 | 29 3 | 73 1 | 60 |
| Nicotinamide | 0 05 | $10^{-4}$ | 15 | 39 0 | 62 0 | 37 |
| Histamine | 0 025 | $10^{-4}$ | 15 | 31 0 | 82 7 | 62 |
| Tyramine | 0 05 | $10^{-4}$ | 15 | 3 7 | 56 6 | 93 |
| Benzedrine | 0 05 | $10^{-4}$ | 15 | 6 2 | 86 7 | 93 |
| Benzedrine | 0 005 | $10^{-4}$ | 15 | 5 5 | 55 8 | 90 |
| Ephedrine | 0 025 | $10^{-4}$ | 15 | 17 8 | 67 0 | 73 |
| *p*-Aminobenzoic acid | 0 02 | $10^{-4}$ | 15 | 56 7 | 56 3 | 0 |
| Glycine | 0 05 | $10^{-4}$ | 15 | 75 6 | 71 6 | 0 |

Barron, Bartlett and Miller[7] have shown that inhibition of choline oxidase by nitrogen mustard can be prevented, or markedly decreased, by the addition of choline to the enzyme previous to, or simultaneously with, the addition of the nitrogen mustard They have shown further that the addition of thiosulphate previous to addition of nitrogen mustard prevents inhibition—the protection in this case being due to a direct immobilization of the nitrogen mustard by thiosulphate

The present paper is a preliminary report of work carried out with the object of finding molecules, other than choline, which will prevent, by direct association with the enzyme, the inhibition of choline oxidase by nitrogen mustard. Rat liver homogenate was used throughout as the source of the enzyme, and in all experiments the nitrogen mustard employed was methyl-*bis*-(β-chloroethyl)amine

Rat liver homogenate (in 0 05 *M* phosphate buffer, *p*H 7 4) was incubated at 37° C in the presence of the protector molecule for fifteen minutes, at which time methyl-*bis*-(β-chloroethyl)amine was added and the incubation allowed to continue for an additional period of time (usually fifteen minutes) The homogenate suspension was then centrifuged, the supernatant liquid removed, and the solid residue washed twice with saline–phosphate buffer mixture before being suspended in distilled water

The choline oxidase activity of such a preparation was compared with that of liver homogenate which had been incubated either alone, or in the presence of the 'protector' alone, or in the presence of methyl-*bis*-(β-chloroethyl)amine alone

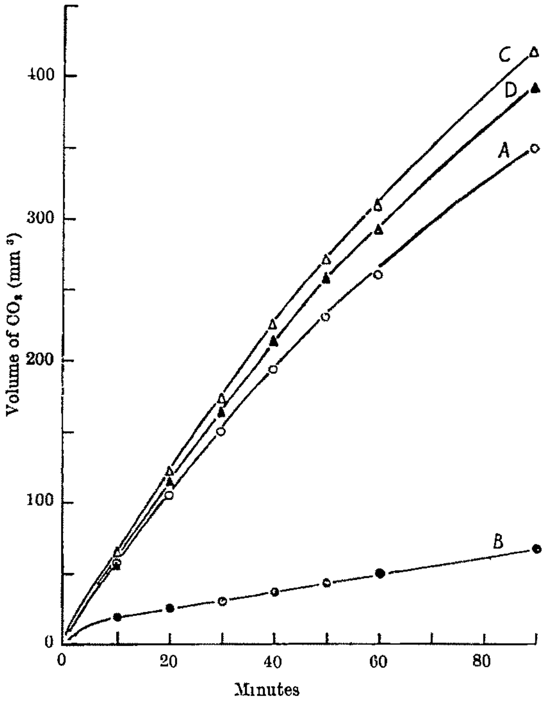
Estimations of choline oxidase activity were carried out both aerobically and anaerobically, employing, in the case of anaerobic oxidation, the method described by Quastel and Wheatley[10] using ferricyanide as the terminal hydrogen acceptor The choline concentration uniformly employed was 0 01 *M*

The first 'protector' molecules tested were ammonium ions and methylamine, these being suggested by the observation of Mann, Woodward and Quastel[11] that choline oxidation is inhibited by ammonium ions and by trimethylamine A preliminary list of the 'protector' molecules tested, and of their effects, is given in Table 1, choline oxidase activity, in all cases, being estimated anaerobically The graph shows a typical series of curves obtained from one such experiment

The same molecules which were tested as 'protectors' of choline oxidase were further tested as inhibitors of this enzyme In this case, estimations of choline oxidase activity were made in the presence of these molecules Some of the results of these experiments are given in Table 2

It will be seen that all those molecules that are capable of protecting choline oxidase from inhibition by methyl-*bis*-(β-chloroethyl)amine are also able to inhibit the oxidation of choline by this enzyme The inhibition produced by these molecules—unlike that produced by methyl-*bis*-(β-chloroethyl)amine—is readily reversed and its magnitude depends on the ratio of substrate to inhibitor

Examination of the results given in Tables 1 and 2 reveals a close correlation between the efficiencies of



Anaerobic oxidation of choline by rat liver choline oxidase Gas phase 93% $N_2$–7% $CO_2$ 0 025 *M* $NaHCO_3$, 0 01 *M* choline, temp 37° C

*A*, Choline oxidase activity of rat liver homogenate incubated 30 min at 37° C , *B* Choline oxidase activity of rat liver homogenate incubated 15 min at 37° C and with $10^{-4}$ *M* nitrogen mustard for 15 min , *C*, Choline oxidase activity of rat liver homogenate incubated 30 min at 37° C with 0 05 *M* benzedrine *D*, Choline oxidase activity of rat liver homogenate incubated 15 min at 37° C with 0 05 *M* benzedrine and for 15 min with 0 05 *M* benzedrine plus $10^{-4}$ *M* nitrogen mustard

Table 2 Inhibitions by anticholine-oxidases

| Inhibitor | Concentration of inhibitor (*M*) | % Inhibition of choline oxidase (Concentration of choline = 0 01 *M*) | |
|---|---|---|---|
| | | Estimated anaerobically | Estimated aerobically |
| Methylamine | 0 05 | 44 5 | — |
| | 0 025 | 24 7 | 21 0 |
| Dimethylamine | 0 025 | — | 32 0 |
| Ethanolamine | 0 025 | — | 16 2 |
| Nicotinamide | 0 05 | 15 3 | — |
| | 0 025 | — | 3 1 |
| Histamine | 0 025 | 52 2 | 28 0 |
| Tyramine | 0 05 | 100 0 | — |
| | 0 025 | 100 0 | 100 0 |
| | 0 01 | 100 0 | 85 3 |
| Benzedrine | 0 025 | 100 0 | 100 0 |
| | 0 01 | 100 0 | — |
| | 0 005 | 86 2 | — |
| | 0 001 | — | 45 2 |
| | 0 0005 | — | 22 0 |
| Ephedrine | 0 025 | — | 77 6 |
| *p*-Aminobenzoic acid | 0 025 | — | 2 4 |
| Glycine | 0 025 | 2 0 | 3 8 |

those molecules that act as protectors against nitrogen mustard and as direct inhibitors of choline oxidase The results also show that amino-acids such as glycine and *p*-aminobenzoic acid are inert as protectors or inhibitors of choline oxidase

The mechanism of the protective action is easily understood on the basis of competitive action between choline and the protector molecule for the enzyme. The phenomenon is strictly analogous to the succinate–malonate competition for succinic dehydrogenase discovered by Quastel and Wooldridge[12] Presumably the protector molecules become attached to the enzyme at the active centre attacked by the nitrogen mustard, inhibiting the irreversible combination brought about by the latter molecule Further treatment of the system, by washing, not only removes the uncombined nitrogen mustard, but also reverses the loose combination between enzyme and protector molecule The activity of the enzyme is thus restored

Attention may be directed to the highly protective effects exercised by benzedrine (phenyl*iso*propylamine), ephedrine, tyramine, methylamine, dimethylamine and even by such molecules as ethanolamine and histamine, all these molecules acting as competitive inhibitors to choline oxidase They act, in fact, as anticholine-oxidases and will be referred to by this term Work is in progress to discover the affinity constants of the anticholine-oxidases both to this enzyme and to other enzymes involving activation of choline (for example, choline esterase and the choline acetylase system)

It will be of distinct interest to discover whether anticholine-oxidases such as benzedrine, etc , which prevent the access of nitrogen mustard to choline oxidase, will also prevent its access to other enzymes and to those structures of the cell involved in the cytotoxic action of nitrogen mustard It will also be of interest to see whether those anticholine-oxidases that have a high affinity for choline oxidase may also have therapeutic effects, particularly in those diseases favourably affected by nitrogen mustard

*Summary*. Benzedrine (phenyl*iso*propylamine), ephedrine, tyramine, methylamine, dimethylamine, ethanolamine and histamine act as competitive anticholine-oxidases. They protect choline oxidase against the inactivating effect of nitrogen mustard

Grateful acknowledgment must be made of a grant from the National Cancer Institute of Canada in aid of this work.

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# ION EXCHANGE

## GORDON RESEARCH CONFERENCE

THE aim of the Gordon Research Conferences is not so much to produce completed scientific papers, but rather to provide an exchange of current results in order to bridge the gap between advanced stages of the work and its appearance in print How necessary this is in a rapidly developing field could be seen from the fact that, in the conference on ion exchange, held in New Hampton, N H , during July 23–28, certain fundamental investigations on ion-exchangers were reported by no less than five different research groups These dealt with the swelling and exchange properties of resins of different degree of chain cross-linking , they showed uniformly that the uptake of swelling water and the speed of exchange decreases with increased cross-linking, while at the same time the specificity of the resin for different ions increases Also, for very high cross-linkage, a very non-ideal behaviour is exhibited by the resins, preference of absorption between two ions changing with the ionic composition of the resin

The first paper—after an informal introduction by the director of the Conferences, Dr W G Parks—was presented by G E Boyd (Oak Ridge National Laboratory, Tennessee). Outlining both the differences and similarities in the thermodynamic approach to partition phenomena such as ion exchange in crystals, in organic exchangers and in surface films, Boyd presented a wide array of experimental results, ranging from the exchange of silver chloride with bromide ion to exchanges of resins of different cross-linking and to the sodium–calcium exchange in stearate films on water. The method of investigation utilized radioactive tracers using gamma-scintillation counters of a high counting accuracy. A novel feature among the many results reported by Boyd was the use of chelating resins, which are highly selective for elements of the transition groups For some cations the binding is so strong that there is no longer a self-exchange, for example, between copper ions and copper-chelate-resin, although this exchange may be rapid in other cases, like strontium

E Glueckauf (Atomic Energy Research Establishment, Harwell), after outlining the current experimental ion-exchange research carried out at the Chemical Research Laboratory, Teddington, and at Harwell, developed a thermodynamic theory of ion-exchange, based on the treatment of the ion-exchange resin as a strong electrolyte, which, due to the cross-linking of the monomer chains, is subjected to internal forces equivalent to a swelling pressure By expressing the chemical potentials by means of activity and osmotic coefficients, and utilizing Harned's rule for these coefficients in mixtures of electrolytes, Glueckauf obtained equations which were in satisfactory agreement with experimental results obtained by J F Duncan, J W Edwards and A W Gardner (Harwell), and which lead to the following general conclusions (*a*) The 'swelling pressure' turns out to be a mildly curved function of the equivalent-volume of the resinate (*b*) While the swelling-pressure term influences the water-uptake of the resin, it does not affect greatly the electrolyte activity in the resin, which therefore, for resins of moderate cross-linkage, can be expressed almost equally well without considering swelling pressures, but not without considering the activity coefficients in the resin phase (*c*) Increased cross-linkage should improve discrimination between different ions, and (*d*), for a given resin, ions of equal charge should be the more strongly absorbed the less they swell the resin, which is in agreement with the general body of experimental evidence (*e*) Mean molal activity coefficients can be assigned to the various metal ion resinates, and in the case of 'Dowex 50' these are approximately half those of the corresponding nitrates This suggests considerable ion-pair formation in the resinates (see also the later paper by W Juda)

Following this, H D Gregor (Polytechnical Institute, Brooklyn) outlined further developments of his theory, which treats the resin phase as an aqueous swelling electrolyte, but neglects activity coefficients He also presented an impressive amount of experimental work on swelling phenomena, electrolyte uptake from concentrated aqueous solutions and exchange behaviour of resins of different degrees of cross-linkage, both for inorganic and organic electrolytes, and for cationic and anionic exchangers Gregor showed that the capacity of an anion-exchanger ('Dowex 2') is effectively independent of the size of the anions, and that the exchange constant for an anion pair *A*—*B* is approximately equal to the ratio of the constants for the pairs *A*—*C* and *B*—*C*, which indicates that there can be only little specific interaction between the different anions absorbed in the same resin

A completely different approach towards the elucidation of the internal structure of cation exchangers was presented by W Juda (Ionics Inc , Cambridge, Mass.) By studying the electrical conductivity and the transference of sodium ions in a sodium cation-exchanger of varying internal sodium chloride content, and by interpreting these results in terms of the dissociation of the sodium resinate, Juda concluded that the sodium resinate was undissociated to a considerable extent He also deduced that the Debye–Huckel theory, applied to systems where one ion is held stationary—as in exchange resins—leads to activities which, in dilute solutions, are half those of the ordinary electrolytes This prediction seems to agree roughly with the activity coefficients calculated by Glueckauf from equilibrium data, though the latter refer to 'concentrated' ion-exchangers

M R J Wyllie (Gulf Res and Dev Co , Pittsburgh) reported some work done by T R E Kressman (Permutit Co , London) on the use of cation exchange resins as diaphragms in concentration cells These behave 'ideally' for dilute solutions, but, for solutions of 0 5 molar and above, transference numbers fall below unity due to the fact that anions will then take part in the transport of electric charge Wyllie also reported potential measurements on cells in which clay membranes (by Marshall) are used These experiments indicate that clay membranes—unlike the organic ion-exchangers—are not porous to water

Anion exchange experiments through protamine-collodion membranes by K Sollner (Nat Inst of Health, Bethesda, Maryland) were reported by H Gregor It was shown that the electrical resistance of collodion membranes after impregnation with the amine increased considerably due to the impermeability of this membrane for cations The conductance of this membrane is greatly affected by the size of the anions, as the 'pores' are of a diameter comparable to that of the larger anions like sulphate and phosphate

K A Kraus (Oak Ridge National Laboratory, Tennessee) presented new data on the use of anion exchangers for separations involving cations of a valency of three or more, by complexing these with hydrogen chloride, hydrogen fluoride and mixtures of these with concentrated ammonium chloride solutions He described very effective separations involving the elements niobium, tantalum, protactinium, iron, hafnium, zirconium, rare earths, and others, and discussed the formation of complex anions of these metals, particularly of iron, on the basis of equilibrium constants obtained under conditions of varying concentration of the complexing halides

Application of ion-exchangers to biological work were discussed by A Reid (South Western Medical School, Dallas, Texas), with particular reference to the treatment of blood Thus calcium ions, the presence of which coagulates blood, can be removed, but the storage qualities are adversely affected, neither has the removal of poisons from the bloodstream been successful yet, as apparently vital substances are removed at the same time G W Bodamer (Rohm and Haas Co , Philadelphia) then reviewed ion exchange phenomena in non-aqueous media, including work by Kitchener and Kressman[1]

The catalytic properties of ion exchange substances were discussed by L P Hammett (Columbia University) and by F Nachod (Sterling Winthrop Res Inst , New York), the chairman of the conference for next year After stressing the technical advantages deriving from the use of catalysts which can be filtered off after use, Hammett discussed experimental results and their implications For example, in ester hydrolysis the relative efficiency of acid resins as compared with hydrochloric acid falls off rapidly with increasing mol-volume of the ester, but the process is almost independent of grain size and therefore not controlled by diffusion, the energy of activation is less than the corresponding one for hydrochloric acid, for which fact the proximity of the organic resin-matrix might be responsible

Dr W Rieman (Rutgers University) then discussed the analytical uses of ion exchangers such as removal of interfering elements, separation into two or more constituents, determination of total salt contents, concentration of trace elements and chromatographic separation of similar ions from each other An experimental test of the theory of chromatography was described by H. C Thomas (Sterling Chemistry Lab , New Haven), who used a Jones reductor tube running at high percolation speed as the prototype of a chromatographic column suffering from 'film diffusion' disturbances Satisfactory agreement between theory and experiment was obtained

Evaluation methods and characterization of their ion-exchange substances were discussed by R. Kunin (Rohm and Haas Co, Philadelphia), W Bauman (Dow Chemical Co, Midland, Michigan) and W Utermohlen (Permutit Co, Birmingham, N J) Kunin reported methods for capacity determination, which differ considerably for strong and weak cation and anion exchangers He reviewed both acid and base exchange constants, and it is of interest to note that, for example, 'IRA 400' is a stronger base than sodium hydroxide and will liberate pure sodium hydroxide solution from sodium salts He also reported the effects already mentioned of different cross-linking on reaction-rates and on the capacity for large cations, and showed that in the case of anion exchangers, too, increased cross-linking results in increased specificity and that very considerable variation of the separation factor occurs as a function of the mol-ratio of the absorbed ions Bauman, after discussing the structure of 'Dowex 50', dwelt particularly on the properties of anions exchangers, such as swelling dependence on cross-linking, chemical stability, titration curves, and exchange constants for a large variety of organic and inorganic anions The last session of the Conference was devoted to a discussion of engineering factors by F J Roberts (Dorr Co, Westport, Conn) and by G P Monet (Du Pont Co, Wilmington, Delaware)

The Conference, under the able chairmanship of Dr R Kunin, dealt on the average with two papers per session, allowing for a full and free discussion, and this contrasted very favourably with the often very over-crowded discussions of many scientific societies A feature of the Conference which also deserves recommendation was the arrangement into morning and evening sessions, which left the afternoons free for either private discussions or mental recuperation E GLUECKAUF

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[1] *J Chem Soc*, 1211 (1949)

# FERROMAGNETISM AND ANTI-FERROMAGNETISM

AN international conference on ferromagnetism and anti-ferromagnetism was held at Grenoble in the first week of July, organised by Prof L Néel under the auspices of the Centre National de la Recherche Scientifique with assistance from the Rockefeller Foundation It was attended by some seventy scientific workers from Europe and America, and a total of about fifty papers were read and discussed in the five days of the conference In this report it will not be possible to mention all the papers or to give a full account of any of them References will be given to published papers where these cover more or less the same ground as the reports presented to the conference, the proceedings are to be published in a single volume towards the end of 1950

The papers on ferromagnetism reflected the great increase in precise knowledge about Weiss domains and their arrangement which has come about in the past few years, and the consequent possibility of more detailed interpretation of magnetization processes Those on anti-ferromagnetism illustrated the recent revival of interest in non-metallic magnetic materials, the considerable accumulation of empirical facts and the beginnings of their reduction to order by generalizing theories.

The most direct experimental evidence for the size and shape of the domains of a ferromagnetic is obtained by applying a magnetic powder to the surface of the material to reveal the outlines of the domains This technique was described by Dr R M Bozorth and illustrated by remarkably clear slides of the domain structures observed on various materials[1] By careful shaping of a single crystal specimen, it is possible to obtain a structure consisting effectively of only two domains, magnetized in opposite directions, with a single boundary wall separating them Investigations of such specimens were described by Dr W. Shockley and by Dr K H Stewart, the former showing a film in which the motion of the wall could be followed as the magnetization changed, the way in which small imperfections in the crystal acted as obstacles to the movement of the wall, through the formation of the 'spike domains' predicted theoretically by Néel[2], could be seen clearly The speed of wall movement in these specimens was found to be controlled by eddy-current effects In the course of the ensuing discussion, Prof L F Bates showed a very beautiful film of Bitter figures formed on a single crystal of cobalt, which has a particularly simple domain structure, he also showed many pictures of domain boundaries on single crystal surfaces of silicon–iron which provided quantitative proof of the essential correctness of the Néel theory

The subject of time-effects in changes of magnetization was taken up more generally by Prof R. Becker, who dealt with the relative importance of eddy currents and of the wall inertia effect predicted by Doring[3] Prof Néel outlined a new treatment of time-effects, showing that the concept of an internal field changing slowly with time and hence changing the magnetization gave results of wider application than the concept of the magnetization itself changing with time He distinguished between 'reversible viscosity', which he attributed to changes in magnetocrystalline anisotropy due to the diffusion of atoms of impurities, and 'irreversible viscosity', due to the effects of thermal fluctuations on the movement of domain walls[4] Experiments on 'irreversible viscosity' were described by J C Barbier[5], and Prof R Goldschmidt showed the importance of time-effects in technical applications The very slow changes in the magnetization of rocks and clays, and the remarkable extent to which they can 'record' past magnetic history, were discussed by Prof E Thellier

Turning from these questions of 'dynamics' to those of 'statics'—the factors controlling the shapes of magnetization curves—the Rayleigh region of the magnetization curve was discussed in the light of Néel's theoretical treatment[6] by Dr L Epelboin and by Dr L Lliboutry, the latter considering the effects of small mechanical stresses as well as of small magnetic fields In the region of high fields, Prof L Weil described recent theories of coercive force and their experimental verification, Néel's theory of coercive force in continuous ferromagnetic media[7] is not easy to check in any detail, but the theory for ferromagnetics consisting of particles so small as to contain only one domain each (Néel[8], Stoner and Wohlfarth[9]) can be checked in various ways by varying temperature, composition and particle size, and agrees well with experiment The technical aspects of high-coercivity materials were treated by Dr K Hoselitz in a review of progress in the field of permanent magnets

Although rapid progress has been made in interpreting magnetization processes in terms of domain structure, there have been no great advances in the more fundamental problems of ferromagnetism, those of the interactions between carriers of magnetic moment leading to a finite spontaneous magnetization in the absence of a field Prof E C Stoner showed how the 'collective electron' approach[10], regarding the carriers of magnetic moment as shared between all the atoms of the lattice rather than attached to individual atoms, could give a general account of the behaviour of ferromagnetics more satisfactory in some respects than those of older theories Prof R Forrer extended his previous interpretation[11] of the saturation moments of alloys in terms of a 'permanent' and a 'supplementary' moment by supposing the latter to be due to an intermittent activation of certain electrons into higher states

Reports of experimental work on saturation moments and allied questions were given by Prof W Sucksmith, who has measured the temperature variation of saturation moment in a cobalt single crystal and in ordered and disordered iron-nickel alloys, Dr P Taglang, who has determined the moments of several series of 'iso-electronic' alloys, Dr A Meyer, who has found the gyromagnetic ratio for iron, nickel and various alloys to be exactly 2, within the small limits of experimental error, and Prof L F Bates, who outlined the main results of his extensive work on temperature changes during magnetization and showed that they can be related reasonably well to other thermal properties by the thermodynamic theory of Stoner and Rhodes[12]

Anti-ferromagnetism, which, until recently, has received much less attention than ferromagnetism, is a consequence of negative interactions between carriers of magnetic moment, interactions tending to make the moments of neighbouring carriers point in opposite directions Néel[13] was the first to show that such interactions can lead to just as great ordering of magnetic moments as can the positive interactions characteristic of ferromagnetism, though the resultant magnetic properties are not usually so striking Recent theoretical developments were outlined at the conference by Prof J H van Vleck The basic idea is to regard the crystal lattice of the material as made up of two interlocking sub-lattices such that all the neighbours of each atom of one sub-lattice belong to the other sub-lattice, the interaction energy will then be a minimum if all the atomic moments of one sub-lattice point in the same direction, antiparallel to all the moments of the other sub-lattice, and this ordered arrangement will actually occur if the temperature is below a certain critical value, the Curie point The quantitative theory, using the concept of a 'molecular field' to represent the interactions, predicts a susceptibility rising slowly to a maximum at the Curie point and thereafter decreasing with increasing temperature Experimental disagreements with the simple theory indicate clearly that interactions between next nearest neighbours are often of even greater importance than those between nearest neighbours, and make it possible to calculate the ratio of the two types of interaction The importance of next nearest neighbour interaction can reasonably be interpreted if the interaction is not a simple exchange one but an indirect one of 'superexchange' with an oxygen atom playing the part of intermediary, as suggested by Kramers[14] and Néel[15] Striking evidence for the division into two sub-lattices below the Curie point has recently been provided by neutron diffraction experiments (Shull[16]), showing a periodicity twice as great as the normal lattice spacing

The experimental study of various anti-ferromagnetic compounds was described by Prof H Bizette, Prof G Foëx, Dr F Trombe, and by Dr C Guillaud Besides determining the Curie temperatures, Prof Bizette has found the preferred directions of orientation of moments, analogous to the 'easy directions of magnetization', for several crystals

At very low temperatures many substances exhibit anomalies of specific heat and magnetic behaviour These were reviewed by Dr N Kurti, who showed that further data are required to decide whether the anomalies are evidence of ferromagnetism or of anti-ferromagnetism, and that the ordinary Lorentz dipole interaction field of $\frac{4}{3}\pi I$ is large enough to be of dominating importance in most cases Similar low-temperature experiments were described by Prof C J Gorter and by Dr G C Garrett

In the simple anti ferromagnetics considered so far, the moments of the two sub-lattices are equal and opposite, so that the resultant spontaneous magnetization is zero Two years ago, Prof Néel introduced the idea[16] that many non-metallic 'ferromagnetics' may in reality be imperfectly compensated anti-ferromagnetics, or 'ferrimagnetics', as he calls them At the conference he was able to show how fruitful this idea has been in explaining the properties of ferrites and other magnetic oxides The metallic ions in the ferrite structure ($Fe_2O_3\ M^{++}O$) are distributed between two different types of site in the framework of oxygen ions, and Néel supposes that the ions in each type form a sub-lattice in the sense indicated above Below the Curie point the material will have a spontaneous magnetization equal to the difference between the magnetizations of the two sub-lattices, and in many cases this differs from zero The theory gives quantitative predictions about the variation of spontaneous magnetization with composition and temperature, the specific heat anomaly at the Curie point and the variation of susceptibility with temperature above the Curie point Refinements to the theory allow for the effect of orbital as well as spin magnetic moment and for the variation of molecular field with temperature[17]

Experiments verifying many of these points were reported by Messrs R Pauthenet and L Bochirol[18], Dr E F Bertaut and Prof Weil[19], working at Grenoble More general studies of the properties of ferrites were described by Prof M Fallot, Dr C Guillaud[20] and Prof A Michel In this work, as in that of Prof R Chevallier on $\alpha$-$Fe_2O_3$, the difficulties in obtaining pure and homogeneous materials are great, leading at times to confusing results A new non-metallic magnetic substance was reported by Dr J H van Santen—the material $LaMnO_3$–$CaMnO_3$, with a perovskite structure, has a transformation point at about 300° K, below which it is ferromagnetic Since neighbouring manganese atoms are separated by an oxygen atom on their line of centres, this is the first known case of indirect interaction due to pure superexchange, it is also the first case in which indirect interactions have been observed to be positive

A general review of ferrites was given by Dr J L Snoek, stressing the advances in basic theory but pointing out the problems of high-frequency behaviour still remaining High-frequency phenomena were also considered in a report by Dr C Kittel on gyromagnetic resonance and an account by Mr F Roberts of experiments on the radio-frequency analogue of the

Faraday rotation of the plane of polarization by a magnetized medium

At the end of the conference, Prof Bates expressed very happily the gratitude which all the participants, particularly those from other countries, felt towards Prof Néel and all who helped to organise the conference for the admirable arrangements and the very pleasant atmosphere which prevailed throughout both the formal sessions and the less formal intervals

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## STATISTICAL METHODS IN BIOLOGICAL AND CHEMICAL EXPERIMENTS

IN January 1949, the New York Academy of Sciences held a conference on "The Place of Statistical Methods in Biological and Chemical Experimentation", the fifteen papers there presented are now published* "as a guide to those workers in the fields of biology and chemistry who wish to learn more about the place of statistics in research". The volume naturally does not give a connected account of the methods of statistical science, but it does provide exceedingly interesting illustrations of the many ways in which the statistician can help a research programme It should be of value to the sceptic requiring to be weaned from his belief that "I don't need statistics in my work", to the teacher in search of examples, and also to the specialist who can appreciate the intrinsic merits of those contributions lying close to his own branch of study

The first two papers, by G W Snedecor and G M Cox, are general accounts of the function of statistical analysis and experimental design Next come several papers descriptive of special statistical techniques, in subjects as diverse as analytical chemistry, nutrition and immunology Four papers on biological assay and three on studies of human populations complete the collection All the authors have something worth saying, and all present their topics with admirable clarity , one or two need special mention

Many readers will be interested to see F W Wilcoxon's survey of the approximate methods of analysis that he has done so much to develop C V. Winder contributes a valuable account of certain applications of statistics in pharmacology, in the course of which he discusses the choice of a metameter for analysis L C Miller compares different techniques for the analysis of assays using quantal responses, making useful comment on the validity and utility of each D Mainland and D D Reid describe some of the statistical problems of research in clinical medicine, with special reference to recent progress in this important and difficult field

D J FINNEY

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* Annals of the New York Academy of Sciences Vol 52, Art 6 The Place of Statistical Methods in Biological and Chemical Experimentation By Edwin J de Beer, Lloyd C Miller and 14 other Authors Pp 789–942 (New York New York Academy of Sciences, 1950 ) 2 25 dollars

## THE TSETSE FLY IN EAST AFRICA

THE report of the East African Tsetse and Trypanosomiasis Organisation for 1949* shows that an integrated attack is being made upon this many-sided problem—research and reclamation are being closely co-ordinated, the medical, veterinary and agricultural aspects are being treated as different facets of a single problem, and progress in East Africa is being correlated at each step with advances made in other parts of the continent

As the director, Dr H M O Lester, points out, the broad aim of the Organisation is the assistance of development in East Africa ; and the reorganisation of research which is in progress and, in particular, the closer liaison between tsetse research and trypanosomiasis research, are clearly having a stimulating effect Detailed work with improved technique is in progress to define exactly the habitats of the different species of tsetse fly so as to make possible the eradication of the tsetse with the minimum interference with vegetation

There are many questions in tsetse biology which must be answered before land-utilization policies can be formulated It is already clear that the eradication of tsetse fly from any area has little value unless the land that has been freed from this pest is required for some specific purpose Until more effective methods of applying insecticides and cheaper methods of clearance are developed, eradication and resettlement will only be economic where there is sufficient pressure of population for the organisation of large-scale undertakings The effect of 'fire exclusion' in exterminating *Glossina swynnertoni* has been confirmed As in Southern Rhodesia, it has been proved in an experimental fenced area of 560 square miles that the destruction of game animals leads to a very great reduction in the numbers of *G morsitans* and the virtual collapse of *G swynnertoni*

On the veterinary side, extensive trials have been carried out on the prophylactic and curative value of the drug 'Antrycide' A cautious attitude was adopted from the outset by the research organisation, and this attitude appears to have been justified The drug has remarkable curative properties against veterinary trypanosomiasis, although severe toxic reactions have occurred and will require further study before its use on a large scale can be recommended As a prophylactic the drug has proved disappointing It is liable to cause prolonged incubation of the disease and so to mask infection , and acquired resistance is so readily developed by *T congolense* and *T vivax* that it appears difficult, if not impossible, to use the drug for large-scale prophylaxis in East Africa

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* East African High Commission East African Tsetse and Trypanosomiasis Research and Reclamation Organisation Annual Report, 1949 By Dr H M O. Lester Pp. 26 (Nairobi East African High Commission, 1950 )

## LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

### Cell Specificity of Histones

DURING the course of our investigations[1,2] on the chemistry of the cell nucleus, it was found[3] that the basic proteins present in the nuclei of the erythrocytes and liver cells of the salmon bear, in contrast to the protamin (salmine) known to be present in the sperm heads, the complete character of histones. At the same time, significant analytical differences were detected between the histones from the two types of cells. These results suggested to us the possibility that each nucleus possesses a basic protein characteristic of the type of cell of which it forms part. This is certainly true of the sperm head of the salmon, for protamin does not occur in other cell nuclei of this species. It appears also to hold for the nuclei of the erythrocytes and liver cells of this species, for the histones isolated from them exhibited marked differences, quite beyond the limits of analytical error, in their arginine contents. Nevertheless, before generalizing our results it seemed desirable to confirm them and, if possible, to extend them to other species. Unfortunately, we have not yet succeeded, despite many efforts, in obtaining a new specimen of fresh salmon blood. We have, however, examined the histones isolated from cell nuclei of other species with the results recorded below.

The assumption has hitherto been tacitly made that the histones extracted from isolated cell nuclei are individual proteins. In fact, however, every histone so obtained has now proved to be composite, consisting of two, and in one case three, components. All the components are basic proteins, and we therefore propose, at any rate provisionally, to describe them all as histones, the component present in preponderating amount being termed the main, and the others the subsidiary, histones. The sulphates of the main histones are less soluble in aqueous alcohol than those of the subsidiary ones and can therefore be obtained more or less readily in what appears to be a pure state. The subsidiary histones are more difficult to purify and have so far only been isolated in a state approaching purity in two instances.

Main and subsidiary histones differ strikingly in composition. Thus, in the products from the nuclei of ox thymocytes, the arginine content accounts for 30 per cent of the total nitrogen of the main histone but only 8 per cent of that of the subsidiary one, the basic properties of the latter being, in fact, mainly due to a high content of lysine. In contrast to this, the corresponding figures for the histones from the nuclei of fowls' erythrocytes are 26.5 per cent and 34 per cent. Here, the subsidiary histone contains considerably more arginine than the main one, but there is evidence of the presence in these nuclei of a third histone of the subsidiary type containing little arginine. Subsidiary histones with a small arginine content have been detected in the basic proteins of nuclei isolated from the following organs: spleen (ox and fowl), liver (ox and salmon), thymus gland (ox and fowl), sperm (cod), a tumour (man). There is thus little doubt that they are of general occurrence in the cell nuclei of animals, but since the majority of them have so far been obtained in insufficient quantity for complete purification, they at present yield no evidence of cell specificity. On the other hand, the subsidiary histone with high arginine content isolated from the nuclei of fowl erythrocytes is cell-specific, for it is absent from both the thymocytes and lymphocytes of the fowl.

The main histones are remarkably constant, both qualitatively and quantitatively, in amino-acid composition, although differences can in some, but not all, cases be detected between those obtained from different species. This is illustrated by their arginine contents shown in the accompanying table.

ARGININE CONTENTS OF MAIN HISTONES

| Species | Source of nuclei | Arginine-N as % of total N |
|---|---|---|
| Ox | Thymus gland | 29.5 |
| | Spleen | 29.5 |
| | Liver | 30.0 |
| Fowl | Erythrocytes | 26.5 |
| | Spleen | 29.8 |
| | Thymus gland | 29.3 |
| Cod | Sperm | 28.6 |
| Salmon | Liver | 30.2 |
| Man | Tumour | 29.5 |
| | Spleen | 30.6 |

These figures clearly give no evidence of specificity among the main histones from different cells of the ox. No differences would, of course, be expected between those from the thymus gland and the spleen, because they are derived from cells (thymocytes and lymphocytes) which are morphologically identical. But the value for the histone from the liver, which might be expected to exhibit specificity, is, within the limits of experimental error, indistinguishable from those of the thymus gland and spleen. These identical arginine contents do not, however, necessarily prove the identity of the histones. On general grounds, it is almost certain that the histones from the various species are species-specific, yet the arginine contents do not permit us to distinguish between the histones from species so divergent as man, ox, fowl (spleen and thymus gland) and salmon. Whether the histones from the ox do, or do not, exhibit cell-specificity must therefore remain, for the present, an open question. On the other hand, there is no doubt that, in the fowl, the histones in the erythrocytes and lymphocytes are cell-specific between these two types of cells. This has been shown above for one of the subsidiary histones. It is also true for the main histones, as is evident from the differences in their arginine contents.

One important consequence of these results lies, in our view, in the possibilities they offer of filling a gap in current genetical theory. It has always been a puzzle to us, as chemists applying our techniques to the field of cytogenetics, how the physiological functions of cell nuclei in the same organism can differ—as presumably they do differ—from one cell-type to another when they all contain identical chromosomes and hence identical genes. The physiological functions of the nuclei are presumably due to the genes which they contain; they should, therefore, be identical in all nuclei of a given organism. If, however, it is postulated that nuclei contain some mechanism for the suppression of the activities of particular genes, or groups of genes, and that this mechanism is specific for each cell type, these difficulties disappear. The demonstration in the work outlined above that some of the basic proteins present in cell nuclei are certainly cell-specific leads to the hypothesis that one of their physiological functions is to act as gene suppressors. It is true that specificity has not been demonstrated for all the histones examined, but, as we have pointed out, such specificity is not excluded by our work

A full account of this work is in course of preparation for publication elsewhere

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Aug 21

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## Carbohydrate and Adenosinetriphosphate in Sea-Urchin Semen

SEA-URCHINS differ from mammals, in which fertilization is internal and the survival of spermatozoa largely depends on extraneous nutrients provided by accessory secretions, in that fertilization takes place after the eggs and sperm have been shed into sea water, which is a poor source of organic nutrients. Furthermore, unlike mammalian spermatozoa which in most species, including man, obtain their metabolic energy through anaerobic and aerobic glycolysis[1], sea-urchin spermatozoa depend on a non-glycolytic and strictly aerobic metabolism, sea-urchin semen is devoid of significant amounts of fructose or other fermentable sugars, and the spermatozoa are incapable of glycolysing sugars added *in vitro*[2]

In a search for glycogen or other intracellular reserve carbohydrate, seminal plasma and spermatozoa, obtained by centrifugation of semen (*Echinus esculentus*), were hydrolysed with potassium hydroxide, the ethanol-precipitable material obtained from the alkaline solution was analysed by several methods Total carbohydrate was estimated by means of anthrone[3], 'reducing sugar', 'yeast-fermentable sugar' and glucose were determined after acid hydrolysis of the ethanol-precipitable material, the amount of 'reducing sugar' was small, being 110 mgm /100 ml spermatozoa (110 mgm per cent), of which only 40 mgm per cent was glucose, identified by the yeast-fermentation test and glucose oxidase[4] The oxidation of this amount of glycogen or glycogen-like material would be inadequate to account for the high oxygen consumption of sea-urchin spermatozoa[5,6] The seminal plasma of *Echinus esculentus* contains little free reducing sugar and no glycogen-like material, though about 200 mgm per cent of some other anthrone-reactive carbohydrate is present

The content of hexose-phosphate phosphorus in sea-urchin sperm was also determined and found to be only 2 mgm per cent

Studies on mammalian spermatozoa have established that both their glycolytic metabolism and motility are related directly to their content of adenosinetriphosphate, in normal ram semen the concentration of adenosinetriphosphate varies from 0 5 to 1 5 mgm per cent of adenine amino-nitrogen[7]. So far, the presence of adenosinetriphosphate in sea-urchin semen has been deduced only from the occurrence of a 'barium insoluble, acid-labile ester'[8] To obtain precise information about adenosinetriphosphate in sea-urchin semen, an attempt was made to isolate it, following the procedure of Parnas and Lutwak-Mann[9] for the quantitative estimation of adenosinetriphosphate in skeletal muscle In a trichloroacetic acid extract from 20 ml semen of *Echinus esculentus*, adenosinetriphosphate was separated as barium salt, and after removal of barium, the pentose, pyrophosphate-phosphorus and amino-nitrogen were estimated in the solution There were 9 9 mgm pentose, 3 8 mgm pyrophosphate-phosphorus and 0 93 mgm of adenine amino-nitrogen per 100 ml semen The molecular ratio of these three agreed satisfactorily with the theoretical ratio 1 2 1 Adenosinetriphosphate therefore occurs as a normal constituent of sea-urchin semen in a concentration similar to that found in ram semen

Adenosinetriphosphate is usually associated with glycolytic metabolism The existence of significant quantities of this substance in sea-urchin spermatozoa raises the question of the role of adenosinetriphosphate in these spermatozoa, the metabolism of which, being non-glycolytic, is very different from that of mammalian spermatozoa, muscle or yeast.

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## Gluconokinase and the Oxidative Path for Glucose-6-Phosphate Utilization

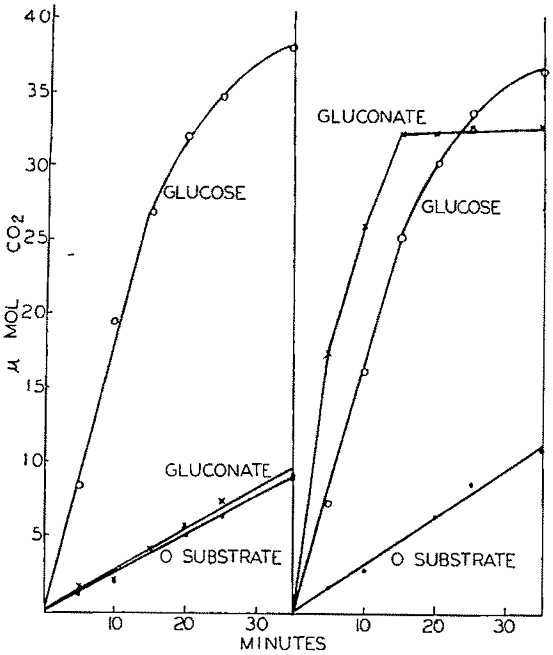
STUDIES of the oxidation of glucose-6-phosphate and 6-phosphogluconate by extracts of many types of cells have indicated the existence of an oxidative pathway leading through pentose phosphate to triose phosphate, in addition to the anaerobic steps of the Embden–Meyerhof scheme We have recently obtained an indication of the potential importance of the oxidative pathway in the economy of the cell from a study of gluconate utilization in *Escherichia coli*, strain B

When a moist sediment of *E coli* grown in glucose medium[1] was ground by hand for two minutes with a fine grade of alumina, essentially all of the organisms were disrupted and many enzyme systems could be extracted with 0 01 *M* phosphate buffer at *p*H 7 0. Among these systems have been demonstrated the oxidizing systems for glucose-6-phosphate and 6-phosphogluconate, hexokinase, the systems for anaerobic conversion of glucose-6-phosphate to triose phosphate, and a weak adenosine pyrophosphatase These systems have been found to have essentially similar activity in the extract from comparable numbers of gluconate-adapted bacteria In addition, this latter extract contained an enzyme, gluconokinase, catalysing the reaction

gluconate + adenosinetriphosphate → 6-phosphogluconate + adenosinediphosphate

The acid liberated in this reaction has been studied in Warburg respirometers (see graph)

Aliquots of the products of anaerobic gluconokinase activity on gluconate and adenosinetriphosphate



Acid-production in the enzymatic transphosphorylation from adenosinetriphosphate to gluconic acid by extracts of adapted and non-adapted bacteria The reaction was measured at 38° in Warburg respirometers in bicarbonate buffer containing $8 \times 10^{-3}$ *M* Mg++ equilibrated with 5 per cent carbon dioxide – 95 per cent nitrogen at *p*H 7 3 At zero time, 3 3 µmol adenosinetriphosphate was added to 0 2 c c of bacterial extract (≙ $1 0 \times 10^{10}$ cells) and 10 µmol substrate in 2 5 c c buffer Left, extract of unadapted cells grown in glucose , right, extract of adapted cells, grown in gluconate

were then analysed enzymatically The reduction of triphosphopyridine nucleotide was followed spectrophotometrically at room temperature at 340 mµ in the presence of purified 6-phosphogluconate oxidizing system from yeast, inactive on gluconate

As can be seen from the graph, addition of adenosinetriphosphate to the enzyme extract alone resulted in the liberation of 0 5 µmol. of acid in 15 min , due to the action of adenosine pyrophosphatase In the presence of gluconate a total acid production of 3 2 µmol had occurred in this time, indicating the presence of 2 7 µmol of phosphogluconate On spectrophotometric analysis of triphosphopyridine nucleotide reduction, it was found that the product contained 2 8 µmol of oxidizable phosphogluconate

The gluconokinase contents of the extracts were also studied by this spectrophotometric method The addition of 0 001 *M* cyanide to the system was desirable to minimize the re-oxidation of the coenzyme by the oxidizing systems of undiluted extracts

Assuming that extraction of hexokinase and gluconokinase was essentially complete and that the turnover numbers and molecular weights of bacterial hexokinase and gluconokinase were comparable to these values for yeast hexokinase[2], it was calculated that an adapted cell contained of the order of a thousand molecules of each of these enzymes The sensitivity of our analytical methods suggests that the unadapted cell contained less than fifteen molecules of active gluconokinase , indeed, no evidence was obtained for the existence of this enzyme in the unadapted cell

When *E coli* is adapted to gluconate, the cells are not simultaneously adapted to D-arabinose, arabonate, 2-ketogluconate or 5-ketogluconate Thus the adaptation seems to consist entirely of the formation of gluconokinase, a transphosphorylating enzyme which effects the formation of 6-phosphogluconate from gluconic acid and adenosinetriphosphate Phosphogluconate does not disappear anaerobically nor aerobically in the absence of oxidized triphosphopyridine nucleotide, and appears to be used exclusively via the oxidative path through pentose phosphate, thereby completely by-passing that part of anaerobic glycolysis resulting in triose phosphate formation

When *E coli* is grown aerobically in a complete mineral medium containing gluconate as the sole source of carbon, the mass duplication time is found to be 57 min , as compared to 49 min with glucose The turbidity increments per mole of substrate are essentially identical, both substrates providing similar quantities of assimilable carbon Thus the rate of utilization of this carbon from gluconate by the single oxidative path approached the rate of utilization of carbon from glucose, which could be degraded both by the oxidative path and by anaerobic glycolysis

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## Structure of the Mycolic Acids of Mycobacteria

R J ANDERSON[1] gave the name 'mycolic acid' to a high-molecular weight fatty acid (m p 58°), isolated from the *H* 37 strain of *Mycobacterium tuberculosis* var *hominis* The structural features of mycolic acid, as elucidated by him, are as follows its probable formula is $C_{88}H_{176}O_4$, with one —COOH, one —OH and one —$OCH_3$ group , pyrolysis at 300° in a vacuum gives a volatile distillate (m p 88°), identified as *n*-hexacosanoic acid, $C_{26}H_{52}O_2$ Chromic acid oxidation breaks up mycolic acid into smaller fragments, among which the following could be identified: stearic acid, *n*-hexacosanoic acid and hexadecane, 1, 16-dicarboxylic acid[2]

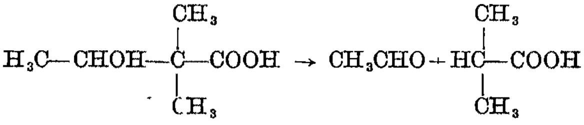
Bovine[3], avian[4] and other strains of Mycobacteria[5,6] contain similar high-molecular weight mycolic acids, the most characteristic feature of which is that they contain a hydroxyl group and that the pyrolysis reaction gives either *n*-hexacosanoic acid or similar acids[3-7]

Nothing was known about the position of the hydroxyl group or the structural significance of the pyrolysis reaction We can now answer both questions

In the course of an extensive study of the lipids of different strains of Mycobacteria, we described a chromatographic method of isolation of mycolic acid[8] and then the chromatographic separation of two probably isomeric (α and β) mycolic acids, differing in melting points and the melting points of their derivatives[9] The elementary analyses of these chromatographically purified mycolic acids and of several of their derivatives confirm the formula $C_{88}H_{176}O_4$ proposed by

R J Anderson[1]. This formula is, of course, considered only as the most probable one; elementary analyses leave an uncertainty of about ± 5 C and ± 10 H.

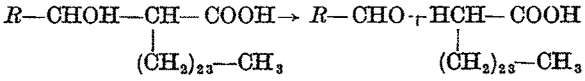
We have shown quite recently that the hydroxyl group of mycolic acid is in the β-position to the carboxyl group[10]. This led us to the hypothesis that the thermal splitting-off of *n*-hexacosanoic acid (for which the presence of the hydroxyl is essential[2]) is analogous to the well-known pyrolysis of β-hydroxy-α,α dialkyl acids[11]. Thus, for example, (I) decomposes on heating into acetaldehyde and *iso*butyric acid (II)[12].



$$H_3C-CHOH-\underset{CH_3}{\overset{CH_3}{C}}-COOH \rightarrow CH_3CHO + H\underset{CH_3}{\overset{CH_3}{C}}-COOH$$

I II

The analogous reaction of mycolic acid (III) would be formulated thus

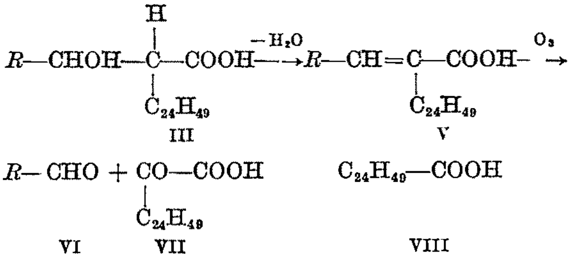


$$R-CHOH-\underset{(CH_2)_{23}-CH_3}{CH}-COOH \rightarrow R-CHO + H\underset{(CH_2)_{23}-CH_3}{CH}-COOH$$

III IV

The real course of the reaction seems to be more complicated, as we have found no aldehyde, but a mixture of methoxyl-free substances.

We have now proved the structure (III) for mycolic acid through the following sequence of reactions: on heating mycolic acid with acetic anhydride containing 10 per cent potassium hydrogen sulphate, water is split off and the α,β unsaturated anhydromycolic acid (V) is formed[8,10]. Both isomers (α and β) seem to give the same anhydromycolic acid[9,10]. Ozonization of anhydromycolic acid (V) should give either α-oxo-hexacosanoic acid (VII) or, by further oxidation, *n*-pentacosanoic acid (VIII).



$$R-CHOH-\underset{C_{24}H_{49}}{\overset{H}{C}}-COOH \xrightarrow{-H_2O} R-CH=\underset{C_{24}H_{49}}{C}-COOH \xrightarrow{O_3}$$

$$R-CHO + \underset{C_{24}H_{49}}{CO}-COOH \qquad C_{24}H_{49}-COOH$$

III V VI VII VIII

In fact, after ozonization of anhydromycolic acid (V), we have isolated an acid (m p 82–83°), which has been identified by X-ray diffraction measurements as *n*-pentacosanoic acid (VIII) (found: C, 78·22; H, 12·92 per cent; $C_{25}H_{50}O_2$ requires C, 78·47; H, 13·17 per cent). α- and β-mycolic acids are thus β-hydroxy-α-*n*-tetracosyl-acids (III).

The $C_{62}$ fragment (VI) of the molecule which is formed by ozonolysis of anhydromycolic acid (V) still contains one methoxyl group and at least one side-chain; the Kuhn–Roth C—$CH_3$ determination of mycolic acid shows the presence of at least three chains[13].

All mycolic acids described by R J Anderson[1,3-6] and the new mycolic acids which we have isolated[14] are characterized by the pyrolysis reaction leading to a long-chain normal fatty acid[7]. We may thus define mycolic acids as high-molecular weight β-hydroxy fatty acids with a long α-side-chain. This seems to be quite a new feature among natural fatty acids.

We wish to thank the Ella Sachs Plotz Foundation for the Advancement of Science, Boston, for a grant, Prof J Tréfouel and Dr J Bretey, Paris, for the facilities they gave us for the preparation of the bacilli (human virulent strain 'Test') at the Pasteur Institute, and Prof J J Trillat and Dr S Barbezat (Laboratoire de Rayons X du C N R S, Bellevue) for the X-ray measurements of the *n*-pentacosanoic acid.

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# Cytochemical Localization of β-Glucuronidase

APPLYING histochemical techniques devised by Friedenwald and Becker[1], it was found[2] that in normal male mouse liver (Fig 1) and kidney, β-glucuronidase activity is mainly confined to the mitochondria. It was considered that the rise in glucuronidase activity shown by biochemical methods to occur in these organs when repair has commenced subsequent to damage[3] might be reflected in a change in the cytochemical picture. This has been found to be the case in experiments with frozen sections

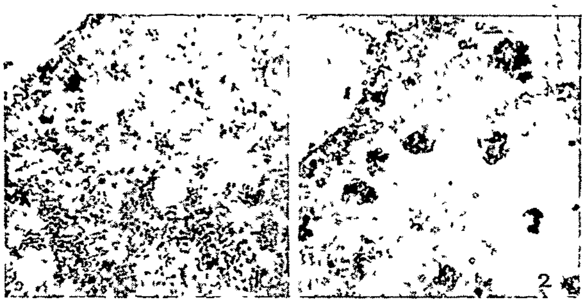

Fig 1. Staining of mitochondria in 20-μ frozen section of normal male mouse liver. 8-Hydroxyquinoline glucuronide method. 8½ hours incubation. Yellow filter, × 500

Fig 2. Staining of chromatin in 20-μ frozen section of regenerating male mouse liver, 7 days after administration of carbon tetrachloride 5·3 gm./kgm. in olive oil. 8-Hydroxyquinoline glucuronide method. 8 hours incubation. Yellow filter, × 500

In both figures a portion of central vein is at the upper left of mouse liver regenerating after partial hepatectomy or carbon-tetrachloride poisoning, using 8-hydroxyquinoline glucuronide as substrate In contrast to the mitochondrial site in normal liver, β-glucuronidase activity as detected by this method now appears to correspond in situation to the nucleus (Fig 2) This did not result from aggregation of the mitochondria, which were seen to be normally situated in sequent sections stained with Iron Hæmatoxylin after fixation in Regaud's fluid On the other hand, Feulgen staining in regenerating liver gave a similar picture to that obtained by the glucuronidase method Normal liver sections stained by the Feulgen method did not in any way resemble those obtained histochemically

It should be noted that biochemical methods suggest that mitochondrial glucuronidase activity remains at the normal level in regenerating liver, whereas the fraction of the enzyme which is soluble in acidified water homogenates rises in activity[4] The apparent discrepancies between the results obtained by the two techniques will form the starting point for further investigation

One of us (J G C ) is in receipt of a full-time grant from the British Empire Cancer Campaign

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## Inhibition of Chymotrypsin by Diethyl *p*-Nitrophenyl Phosphate

CHYMOTRYPSIN displays both esterase and proteolytic activity, and it has recently been shown[1] that this enzyme is inhibited by di*iso*propyl fluorophosphonate and that loss of esterase activity is paralleled by loss of proteolytic activity Diethyl *p*-nitrophenyl phosphate (*E* 600) resembles di*iso*propyl fluorophosphonate in being a very powerful anticholinesterase We have found that it will also inhibit chymotrypsin, and have been studying the system chymotrypsin – diethyl *p*-nitrophenyl phosphate as a convenient model for other esterase systems, since the physical data for this enzyme (purity, molecular weight, etc ) are among the more accurately known.

Our sample of crystalline chymotrypsin was found to be 50 2 per cent pure (the remainder being magnesium sulphate) by using Anson's method of estimation[2] (digestion with denatured hæmoglobin in phosphate buffer, *p*H 7 7 at 25°, and using Northrop's value of $(0\ 038\ \mathrm{T\,U})^{\mathrm{Hb}}_{\mathrm{mgm\,P\,N}}$ for the activity of pure enzyme) The inhibitory effect of diethyl *p*-nitrophenyl phosphate was followed by incubating the enzyme in buffer *p*H 7 7 at 25° for 18 hr and the proteolytic activity estimated as above. A concentration of diethyl *p*-nitrophenyl phosphate of $8 \times 10^{-6}$ *M* gave 50 per cent inhibition of 0 1 per cent chymotrypsin under the above conditions A yellow colour developed in the solutions during incubation and the absorption spectrum corresponded to that of nitrophenol Measurement of the absorption at 400 mμ using a Beckmann photo-electric absorptiometer was a convenient method for the assay of nitrophenol It was found that more nitrophenol was liberated in the presence of the enzyme than in its absence the results of a typical experiment were as follow

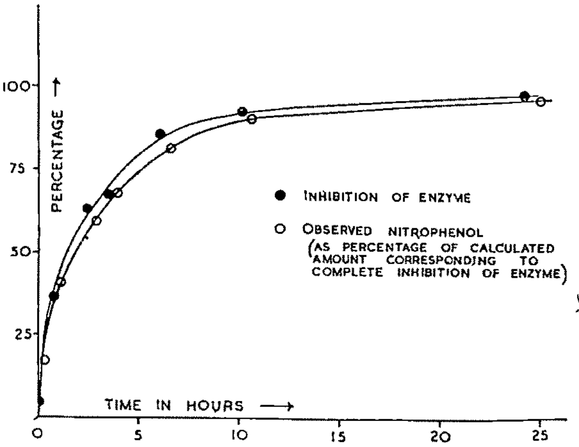
| | Solution | Nitrophenol concentration observed |
|---|---|---|
| (*a*) | Chymotrypsin (0 993 mgm /ml ) + *E* 600 ($10^{-3}$ *M*) in phosphate buffer *p*H 7 7 incubated for 18 hr at 25° | $3\ 00 \times 10^{-5}$ *M* |
| (*b*) | Control, as above, but omitting chymotrypsin | $1\ 17 \times 10^{-5}$ *M* |
| | Extra nitrophenol produced in (*a*) | $1\ 83 \times 10^{-5}$ *M* |
| | Inhibition of enzyme after 18 hr = 100 per cent | |

Using a value of 27,000 ± 1,000 for the molecular weight of the chymotrypsin (see Jansen *et al*[2]) and assuming an equation

$$\text{Chymotrypsin} + (\mathrm{EtO})_2\mathrm{PO\ OC_6H_4NO_2} = (\text{Inhibited chymotrypsin-}\mathrm{PO(OEt)_2}) + \mathrm{HO\ C_6H_4NO_2}$$

the theoretical concentration of nitrophenol expected would be $(1\ 81 \pm 0\ 07) \times 10^{-5}$ *M*

Simultaneous determinations were made of the nitrophenol liberated and the percentage inhibition of the enzyme during 18 hr, and the results are shown in the accompanying graph The two curves are essentially coincident, and a linear relationship is found on plotting nitrophenol liberated against percentage inhibition These results suggest that there may be only one 'active centre' in the chymotrypsin molecule, in agreement with the findings of Jansen *et al*[3], who found that chymotrypsin inhibited with di*iso*propyl fluorophosphonate containing phosphorus-32 had 1 1 atoms of marked phosphorus to 1 molecule of enzyme after recrystallization



As a working hypothesis of the mechanism of esterase activity, we think it probable that one molecule of substrate reacts at the active centre of the enzyme and hydrolysis occurs Normally, both the alcohol and acid moieties then leave the active centre and the cycle is repeated, but if certain inhibitory substrates are used, such as diethyl *p*-nitrophenyl phosphate or di*iso*propyl fluorophosphonate, the acid portion of the substrate (that is, —PO(O*R*)$_2$) remains attached after hydrolysis and blocks the active centre, while the other portion (for example, nitrophenol or hydrogen fluoride ?) is liberated Further work on the kinetics of the reaction and the use of radioactive inhibitors is in progress

Our thanks are due to Armour and Co , of Chicago, for a gift of crystalline chymotrypsin, and to the Agricultural Research Council for financial support

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## Beta- and Gamma-Globulin Tetanus Antitoxin of the Hyperimmune Horse

Past work has indicated that fractionation of diphtheria antitoxic horse serum yields fractions of which the dilution ratio, and hence the firmness of combination, may show considerable variations There was a definite correlation between the *in vitro/in vivo* ratio and the dilution ratio[1] Kekwick and Record[2] examined electrophoretically pure gamma- and beta-globulin from hyperimmune horse sera, and found that both fractions had antitoxic activity and that they differed in their $L+/L_f$ ratios and in their speed of flocculation It was of interest to investigate whether this was a general phenomenon, or one confined to the diphtheria toxin–antitoxin system, by studying the relation between tetanus toxin and horse tetanus antitoxic sera

Qualitative differences between tetanus antitoxic sera have been observed by Hartley (quoted in ref 3) and Petrie[4]. Dilution tests[5] on two sera and two fractions from one of them indicated a similarity to the diphtheria toxin–antitoxin system, and Kekwick[6] demonstrated that both gamma- and beta-globulin were antitoxic

Gamma- and beta-globulin were obtained by fractionation with sodium sulphate followed by electrophoretic separation[2,6] from sera of horses hyperimmunized intramuscularly with tetanus toxoid Flocculation always gave multiple zones The flocculation zone due to tetanus toxin was determined by preparing floccules near each of the indicating mixtures, using proportions providing excess of toxin or antitoxin The floccules were washed and then added to a suitably diluted solution of antitoxin Toxin–antitoxin floccules absorb considerable quantities of antitoxin and may be distinguished in this way from floccules derived from flocculation zones involving other antigens[7] $L_f$ and $K_f$ were determined at 49° C in phosphate buffer, $I = 0\ 2$, *p*H 8

The extent to which toxin–antitoxin dissociates on dilution was tested in two ways (1) the amount of an antitoxin was found that would neutralize an $L+/5$ dose of toxin and was compared with the amount required to neutralize an $L+/250$ dose of toxin[5] , (2) the amounts required to neutralize the test dose of toxin in the mouse and in the guinea pig were compared ($M/G$ is ratio of $L+$units per ml in the two cases [4])

| Antitoxin | $K_f$ | $\frac{L+\text{units per ml}}{L_f}$ | | $\frac{M}{G} \times 100$ | $\frac{L+/250}{L+/5} \times 500$ |
|---|---|---|---|---|---|
| | | *a* | *b* | | |
| 'Keeble' serum | 145′(1) | 1 5 | 2 2 | 87 | 68 |
| 'Keeble' gamma-globulin | 69′(2) | 2 6 | 4 4 | 60 | 55 |
| 'Keeble' beta-globulin | 165′(1) | 1 2 | 1 3 | 106 | 95 |

(1) 6 units/ml of flocculation mixture
(2) 4 2 units/ml of flocculation mixture
(*a*) Determined from $L+/5$ measurements
(*b*) Determined from $L+/250$ measurements,

It may be concluded that, in flocculating, tetanus-toxin–antitoxin systems resemble diphtheria toxin–antitoxin mixtures The gamma-globulin combines more avidly than the beta-globulin with the toxin , it dissociates *less* on dilution

This work will be presented in detail elsewhere Our thanks are due to Dr R A Kekwick for suggesting this investigation and for his encouragement.

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## Connective Tissue Permeability and the Mode of Action of Hyaluronidase

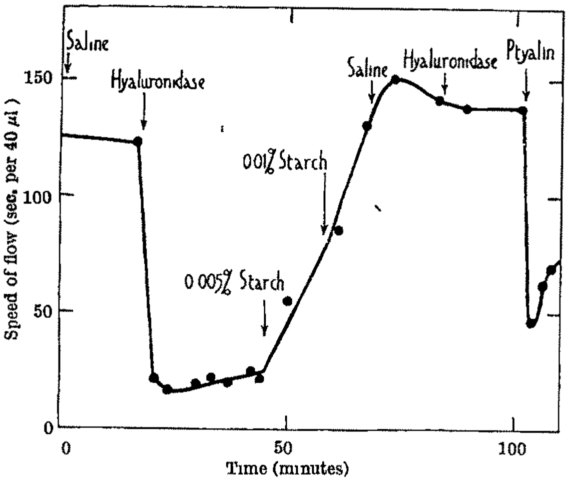
The following observations would seem to throw fresh light upon the question of the mode of action of hyaluronidase on connective tissue permeability

A sheet of fresh fascia from the flank of a mouse was fixed as an occluding membrane across the end of a glass tube of some 0 5 cm internal diameter rubber rings were found to be the best method of sealing the membrane to the tube Particular care was taken not to damage the membrane during dissection or to stretch it unduly afterwards

Fascial membranes prepared in this way were always found to be permeable to physiological saline, and at a pressure of 12 cm water the rate of flow through them was of the order of 60 µl per min This rate was almost immediately increased by some ten times when hyaluronidase (Benger's 'Hylase', 10 units per ml ) was added to the saline perfusate The same result was obtained with a saline extract of mouse testis

This effect of hyaluronidase was counteracted by dilute solutions of certain substances of large molecular size Thus when the following substances, at the w/v per cent concentration indicated, were perfused, the original state of permeability was restored within an hour starch, 0 005 per cent , agar, 0 01 per cent , gum arabic and citrus pectin, 0 05 per cent , leaf gelatine, 0 1 per cent , chondroitin sulphate and dried serum, 0 2 per cent Mouse serum at a dilution of 1/40 and human synovial fluid at 1/100 were similarly effective

In the case of synovial fluid, and to some extent with serum and pectin, the slowing of flow was partly due to viscosity, since it took place rapidly and normal flow was restored almost at once when saline was substituted But with starch, agar and gum arabic the slowing was gradual, regular and also permanent, inasmuch as no quickening of flow took place when saline was again perfused



Connective tissue membrane perfused at a pressure of 12 cm water. Acceleration of flow caused by hyaluronidase counteracted by dilute starch. Flow afterwards accelerated by ptyalin

With the exception of synovial fluid, where a slight effect was observed, hyaluronidase had no further accelerating action upon the slowed rate of flow brought about by perfusion with these substances. But it was found that ptyalin (human saliva diluted by 1,000) had an effect upon a starch-treated membrane which imitated the former action of hyaluronidase precisely (see graph).

It is apparent that certain substances of large molecular size can, even in considerable dilution, slow the rate of flow when passed through a fascial membrane. This effect is independent of viscosity, and in the case of starch was clearly due to the accumulation within the membrane of starch molecules or molecular aggregates. There is no reason to doubt that the same mechanism was mainly responsible for the slowing action of the other substances mentioned with the exception of synovial fluid, with which viscosity effects predominated.

Connective tissue may be looked upon as a fabric of protein fibres[1], and it would seem that some degree of 'water-proofing' of the fabric by large molecules is possible. On this view, the sudden rheological effect of hyaluronidase, an effect, one would think, far too rapid to indicate the action of this enzyme on any very great quantity of substrate, is due to removal of those hyaluronic acid molecules which normally, to some extent, 'waterproof' the fabric. It is significant that, after treatment with hyaluronidase, the normal permeability of the tissue could be quickly restored by concentrations of serum far smaller than found in most pathological exudates. In spite of its dramatic effects on fresh tissue, it would seem, therefore, that hyaluronidase must be of negligible importance in relation to the spread of such exudates.

A detailed account of these findings will be published in due course. I wish to thank Dr. C. R. Boyes, of Messrs. Allen and Hanburys, Ltd., for providing me with citrus pectin and chondroitin sulphate, and Dr. Frank Fletcher, of Benger's, Ltd., for a supply of 'Hylase'.

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July 5.

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## Phosphorylation and Absorption of Sugars in the Rat

IT is known that the absorption of sugar from the intestine is accompanied by an increased phosphorylation of sugar in the mucosa[1-3]; but the evidence available does not show clearly if this phosphorylation plays a direct or an indirect part in absorption. It was felt that an examination of the properties of the hexokinase of the mucosa might help in deciding this question.

Homogenates of rat intestinal mucosa (1 gm. of tissue in 4 ml. homogenate) were employed, hexokinase activity being followed by the disappearance of free sugar from the digest in the presence of adenosinetriphosphate, using the method of Nelson[4]. The digest was incubated at 30° C. in open test tubes, and contained veronal-acetate buffer pH 8·0, 0·05 $M$, magnesium chloride, 0·01 $M$, sodium fluoride 0·06 $M$; as well as appropriate concentrations of sugar and adenosinetriphosphate. Total volumes of 1·5–2·5 ml. were used, of which one-third by volume was homogenate. No sugar disappearance occurred in the absence of adenosinetriphosphate. High concentrations of adenosinetriphosphate were required, because of the intense adenosinetriphosphatase activity of the homogenate. The phosphatase activity present did not interfere markedly with the sugar disappearance during the first 10 min. of the hexokinase reaction.

Water homogenates were used for studying the phosphorylation of D-glucose, D-fructose, D-mannose and D (–) xylose. At a sugar concentration of 0·0055 $M$, and an adenosinetriphosphate concentration of 0·033 $M$, the average hexokinase activity towards glucose was 0·80 ± 0·12 mgm. glucose disappearing per millilitre homogenate in 5 min. (15 rats). Water homogenates gave no activity towards D-galactose, as was found by Meyerhof with brain[5], but, as with brain, good activity was obtained when Meyerhof's magnesium Ringer solution was employed in the preparation of the homogenates. These Ringer homogenates gave an activity towards glucose of 0·64 ± 0·07 mgm. glucose disappearing per millilitre homogenate in 2·5 min. (13 rats). The phosphorylation rates of the other sugars, measured under the same experimental conditions, relative to that of

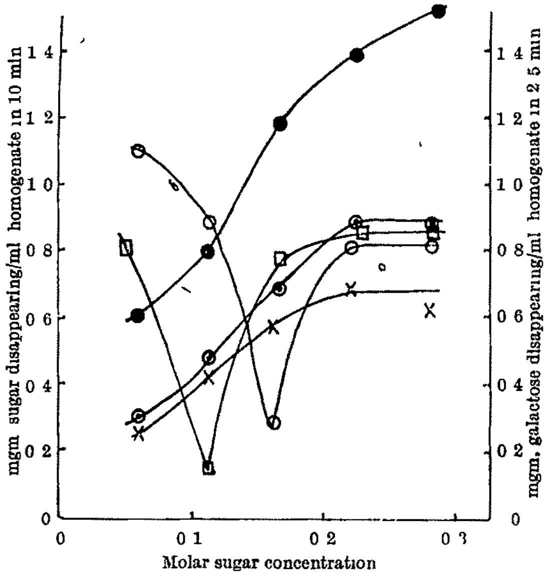

Fig. 1

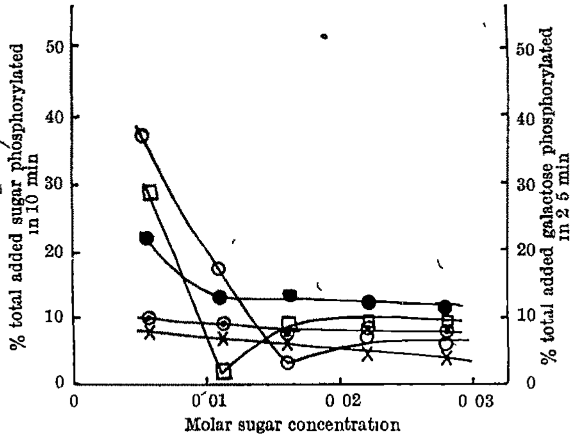

Fig 2

glucose (= 100), are given in the accompanying table. The relative absorption rates, determined on 29 rats of the same stock, are included for comparison. Similar relative absorption rates are given in the literature[1,7]. The technique of Cordier and Touzé[6] was used to determine the absorption rates. It was found that a group of five rats would absorb 57 ± 5 mgm. glucose in 30 min. from 2 ml. of a 0·33 $M$ (isotonic) solution injected into the small intestine. Other sugars were examined in the same way. The observed hexokinase activity was sufficient to account for the phosphorylation of at least 59 per cent of the glucose absorbed in 5 min.

Relative Phosphorylation and Absorption Rates

| | Galactose | Glucose | Fructose | Mannose | Xylose |
|---|---|---|---|---|---|
| (*a*) | — | 100 | 53 | 32 | 29 |
| (*b*) | 134 | 100 | 50 | — | — |
| (*c*) | 112 | 100 | 52 | 25 | 26 |

(*a*) Phosphorylation rates in water homogenates
(*b*) Phosphorylation rates in Ringer homogenates
(*c*) Absorption rates

The accompanying diagrams show the effect of raising the sugar concentration upon the phosphorylation rates of the sugars. The 'dip' in the glucose concentration curve was observed in 22 out of 25 rats examined, and is flattened when the concentration of adenosinetriphosphate is raised. The phosphorylation-rates of the different sugars are found to vary with sugar concentration in much the same way as do their absorption rates[1].

The effect of variation in concentration of adenosinetriphosphate upon the rate of the hexokinase reaction depends upon the sugar concentration, and is different for different sugars. At a sugar concentration of 0·0055 $M$, the rate of the reaction with fructose remains constant over a concentration range of 0·013–0·04 $M$ adenosinetriphosphate, but the rate with glucose varies with the concentration of adenosinetriphosphate. Meyerhof (*loc. cit.*) found brain homogenates to behave in a somewhat similar manner, alterations in the concentration of adenosinetriphosphate affecting the glycolysis rates with glucose and fructose differently, at the same sugar concentration.

Phosphatase activity was studied in a manner similar to that used for hexokinase, without adenosinetriphosphate, the appearance of free sugar in the digest being followed. Sugar is set free from glucose-6-phosphate and from fructose-6-phosphate at the same rate; at an ester concentration of 0·0055 $M$ this is equivalent to 0·75 mgm. sugar appearing per millilitre homogenate in 5 min.

These observations suggest that hexokinase participates directly in sugar absorption, and with the phosphatase functions in a phosphorylation-dephosphorylation cycle. The absorption rates of different sugars are determined by the behaviour of the hexokinase, which may, in its turn, be influenced by the amount of adenosinetriphosphate available *in vivo*.

These results will be reported in detail elsewhere.

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## Bacteriostatic Substances in the Unsaponifiable Fraction of Cod-liver Oil

We have investigated the unsaponifiable fraction of cod-liver oil and found that it has a strong bacteriostatic effect; especially interesting is the fact that *in vitro* it suppresses growth of *M. tuberculosis*. The non-saponifiable matter was chromatographed over alumina, the fraction most firmly held having the strongest activity. This fraction was a viscous oil and did not contain sterols, vitamin A or vitamin D. Only hydroxylic compounds (probably chiefly unsaturated) were present, and among these α-glyceryl ethers were found. After hydrogenation the bacteriostatic effect decreased considerably. The fraction inhibited the growth of *M. tuberculosis* in concentrations of 1–3 μgm. per ml. Sauton medium.

In animal experiments (guinea pigs) a daily dose of 30 mgm. was not active against infection with tubercle bacilli; moreover, the substance proved to be more or less toxic.

Details will be published elsewhere.

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## The Xylan of *Rhodymenia palmata*

Barry and Dillon[1] reported the isolation from the red seaweed *Rhodymenia palmata* of a polysaccharide which gave D-xylose on hydrolysis. Our special interest in xylans[2] has led us to investigate this substance more fully as part of the research programme of the Scottish Seaweed Research Association. Since work on this subject has also been continued in University College, Galway, we have agreed with Prof. T. Dillon to publish a preliminary account of our findings.

The polysaccharide, $[\alpha]_D - 96°$ ($H_2O$) (*cf.* esparto xylan $[\alpha]_D - 91°$ (NaOH)) gave xylose only on hydrolysis. Periodate oxidation showed that 80 per cent of the xylose residues possess α-glycol groupings and these are linked, therefore, through $C_{(1)}$ and either $C_{(2)}$ or $C_{(4)}$, if the possibility of the presence of furanose residues is discounted The resistance to attack of the remaining 20 per cent can be explained only by the presence of 1 3-linkages

Complete methylation and hydrolysis gave 2-methyl-, 2 3-dimethyl-, 2 4-dimethyl-, and 2 3 4-trimethyl-D-xylose, the proportion of the last compound agreeing with the presence of one non-reducing end-group for every 20–21 xylose residues This separation was achieved by filter-paper chromatography, a more detailed analysis must await the use of the cellulose column It is evident, however, that this marine xylan contains both 1 3- and 1 4-unions between the xylose units, and that even apart from this difference in its general structure, it differs from esparto xylan[2] The possibility that the substance examined is a mixture of two xylans built up with 1 3 and 1 4-linkages respectively appears to be discounted by the fact that careful fractionation of both the acetate and the methyl derivative failed to effect any separation In a general way, therefore, this xylan appears to be analogous to lichenin[3], which has been shown to contain D-glucopyranose units linked through the 1 3- and 1 4-positions in the proportion of about 1 in 3

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[1] Barry and Dillon, *Nature*, **146**, 620 (1940)

[2] Chanda, Hirst, Jones and Percival, *J Chem Soc*, 1289 (1950)

[3] Meyer and Gurtler, *Helv Chim Acta*, **30**, 751 (1947) Boissonnas, *ibid*, 1703 (1947)

As obtained by us, the xylan of *R palmata* after purification contained 0 5 per cent of ash and had $[\alpha]_D - 99\ 3°$ ($c = 1\ 44$ $H_2O$) Methylation followed by hydrolysis gave the same methyl xyloses as those obtained by the Edinburgh workers, and they were roughly estimated to be in the same proportion

The xylan was partially oxidized by periodic acid, and the oxidized product gave with ammonia a white precipitate which, after purification, contained 2 7 per cent of nitrogen This substance was assumed to be an aldehyde ammonia formed by the combination of two molecules of ammonia with each pair of aldehyde groups produced by the oxidation, and on this basis it was calculated that one xylose residue in seven was vulnerable to periodic acid In view, however, of the much higher figure for α-glycol units found by Percival and Chanda, it must be assumed that only a small fraction of the total aldehyde groups combine with ammonia before precipitation arrests further action

Titration of the formic acid produced by oxidation with potassium periodate[1] gave 1 mole of formic acid to 7 xylose residues, while determinations of the formaldehyde produced by periodate oxidation (at the reducing end of the chain)[2] gave 1 mole to 39–40 residues

These results suggest that this xylan has a structure similar to that proposed by Chanda, Hirst, Jones and Percival[3] for esparto xylan, namely, a chain of xylose anhydride units with one branch The algal xylan, however, appears to contain only about 40 xylose units in the molecule as against 75 in the esparto product The high proportion of formic acid points to a linkage at the reducing end through $C_{(4)}$, which would yield 2 moles of formic acid, rather than through $C_{(3)}$, which would yield 1 mole only

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[1] Halsall, Hirst and Jones, *J Chem Soc*, 1427 (1947)

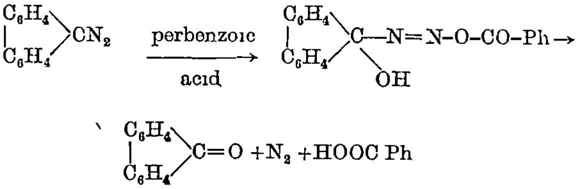
[2] Bell, *J Chem Soc*, 992 (1948)

[3] Chanda, Hirst, Jones and Percival, *J Chem Soc*, 1289 (1950)

## Action of Perbenzoic Acid on Diphenylene Diazomethane

WHEN an ice-cold benzene solution (12 c c) of perbenzoic acid (0 6 gm) was added (during a period of 5 min) to a benzene solution (12 c c) of diphenylene diazomethane (0 5 gm) at 45°, a vigorous evolution of gas was observed The temperature was kept at 45° for a further 10 min and benzoic acid removed by extraction with sodium carbonate The product was dried *in vacuo* and the residue recrystallized from dilute methyl alcohol yielding fluorenone (0 15 gm)

This seems to be the first case where $>CN_2$ has been directly transformed to $>C = O$



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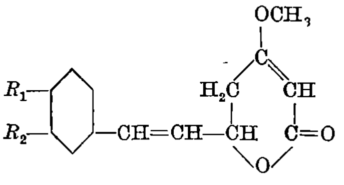
June 21

## Synthesis of Kawain

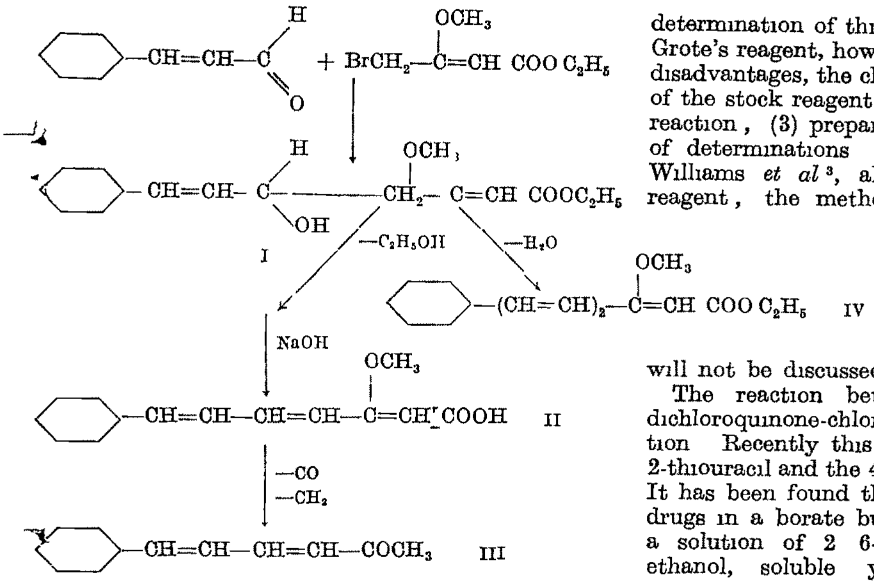
DURING 1914–33 Borsche[1] isolated several structurally related substances from kawa resin He proposed the general formula



for example, kawain (I) $R_1 = R_2 = H$

Neither Borsche nor the other workers in this field have synthesized any of these substances

It occurred to us that a relatively simple synthesis should be possible by a Reformatzky condensation between cinnamic aldehyde or its derivatives and ethyl-γ-bromo-β-methoxycrotonate Under the conditions of the reactions the initial condensation



product was expected to lose water, giving the triply unsaturated ester IV, or to split off alcohol, thereby giving the lactone I

We have carried out this condensation and were able to isolate in small yield a substance of formula $C_{14}H_{14}O_3$ (calc. C, 73 0, H, 6 1, $OCH_3$, 13 5, found C, 72 8, H, 6 2, $OCH_3$, 14 0) However, the melting point was 145°, whereas Borsche[2] gives the melting point as 102° for kawain

When heated with a solution of sodium hydroxide, the substance behaved as a lactone We were able to isolate the free acid (II) as pale yellow crystals (m p 184°) The kawaic acid obtained by Borsche in a similar manner from kawain is described as a yellow substance (m p 185°)

By decarboxylation and demethylation of this acid we obtained the ketone (III), likewise obtained by Borsche from kawaic acid It was identified as its 2 4 dinitrophenylhydrazone (m p 218°)

There seems, therefore, no doubt that a synthesis of the substances from kawa resin is now possible

A detailed account of this work will appear elsewhere Work on these syntheses is being continued

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[2] Borsche, W , *Ber* , **63**, 2414 (1930)

## A New Colour Reaction for Methylthiouracil

LITTLE information is available on the excretion of methylthiouracil, particularly after its administration in hyperthyroidism Since the drug is now widely prescribed for the reduction of hyperthyroid and thyrotoxic states, we have been interested in the development of a colour reaction for it capable of adaptation on a quantitative basis Up to the present, colorimetric methods for the determination of thiouracil and propylthiouracil have been based upon the original procedure of Anderson[1], who applied Grote's reagent[2] for the determination of thiourea and compounds containing the C=S group to the determination of thiouracil in urine Methods using Grote's reagent, however, are subject to a number of disadvantages, the chief of which are (1) instability of the stock reagent, (2) tedious adjustment of the reaction, (3) preparation of standards for each set of determinations Except for the procedure of Williams *et al*[3], all workers report an unstable reagent, the method of Williams *et al* has the disadvantage of a 12-hr digestion procedure. Since the colour reaction described in this communication represents a new approach to the subject, previous work will not be discussed further

The reaction between pyrimidines and 2 6-dichloroquinone-chloroimide has been under investigation Recently this work was extended to include 2-thiouracil and the 4-methyl derivative of the latter It has been found that when small amounts of the drugs in a borate buffer (*p*H 8 0) are treated with a solution of 2 6-dichloroquinone-chloroimide in ethanol, soluble yellow-coloured products are obtained Fearon[4] has shown that uric acid reacts with the chloroimide reagent under similar conditions with the formation of an orange/yellow-coloured product The same author[4] applied the reaction to the determination of uric acid in urine, and noted that thiourea, creatinine, and a number of other urinary solutes also gave coloured products in the reaction I have found, however, that the yellow-coloured products obtained with thiouracil and methylthiouracil in the reaction are readily soluble in chloroform, whereas those due to uric acid, creatinine, and the majority of urinary solutes are completely insoluble By this means the colour reaction for thiouracil and methylthiouracil has been rendered specific Using this reaction, it has been found possible to determine with accuracy methylthiouracil in urine, details of the method will be published elsewhere The sensitivity of the reaction for methylthiouracil is in the region of 10 μgm , and as a result the reaction is applicable to the determination of this drug in plasma, this work will be described elsewhere

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## Chromatographic Separation of the Saturated $C_2$–$C_8$ Fatty Acids from a Single Small Sample

IN order to study some aspects of nematode metabolism, we found it necessary to analyse quantitatively single small samples of mixed fatty acids which varied in constitution from acetic to octanoic The only quantitative method reported[1] is time-consuming and unsuitable for a large number of analyses It has now been possible to extend the procedures described by Ramsey and Patterson[2] and

Elsden[3], so that a single sample containing the acids mentioned above can be analysed in two hours

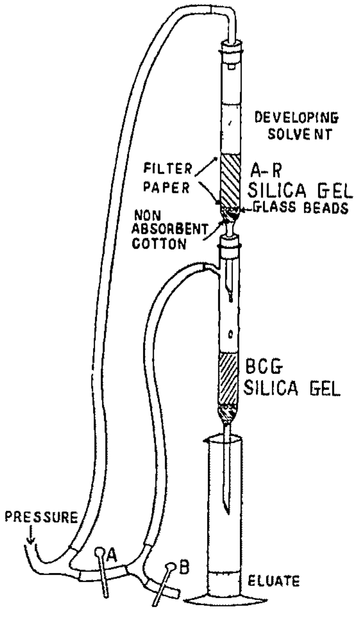
The silica was obtained by acidifying commercial sodium silicate solution to *p*H 8 5 (thymol blue) at 22° C After suitable ageing[4], the precipitate was washed and dried at 110° C for forty-eight hours, then sized (sieve aperture, 0 589 mm ) and dried for a further forty-eight hours This silica had a large water capacity (Table 1) Six different batches of silicate solution obtained from two manufacturers yielded virtually identical products

Table 1 PREPARATION OF COLUMNS
(2 gm silica)

| Column | Indicator (0 2%) (ml ) | NaOH (0 1 *N*) (ml ) | Water (ml ) |
|---|---|---|---|
| Alphamine red *R* | 1 0 | 0 8 | 1 0 |
| Bromocresol green | 0 5 | 2 1 | 0 2 |

Two columns were prepared after thorough mixing of the silica with the solutions shown in Table 1 It will be noted that the two mixtures, one containing *R*—$NH_4$ indicator[5] (alphamine red *R* (Herstein), Amend Drug and Chemical Corp , New York) and the other bromocresol green, differed considerably in the amount of alkali present, with a resulting difference in the $R_F$ value or threshold volume for any given acid The prepared silicas were slurried in chloroform-butanol (199 1) and packed into glass tubes (14 mm internal diameter) according to the technique described by Neish[6] The two columns were then joined as shown in the accompanying diagram Flow of solvent through the lower column was regulated by alternate opening of the pinch-cocks *A* and *B*, so that the solvent present on the surface of this column never exceeded a few drops

In a complete analysis the following procedure was used The solution of acids in 2 ml of chloroform-butanol (99 1) (v/v) was washed into the alphamine red *R* column in the conventional manner During subsequent development with chloroform-butanol (199 1), octanoic and hexanoic acids passed rapidly through this column into the bromocresol green column Here they were fractionated, and the portion containing octanoic acid was collected and titrated



The hexanoic acid band was now visible provided that this acid was present in amounts equivalent to 0 3 ml of 0 01 *N* alkali Development was continued until the butyric acid band was on the point of leaving the alphamine red *R* column At this time the columns were separated, and independent elution was completed with appropriate solvents

Table 2 COMPLETE ANALYSIS WITH DOUBLE COLUMN

| Column | Acid | Threshold (ml ) | Chloroform-butanol* | Volume collected (ml ) | Titration (ml of 0 01 *N* NaOH) | Recovery (%) |
|---|---|---|---|---|---|---|
| Bromo- | $C_8$ | — | 199 1 | 12 | 0 82 | 98 |
| cresol | $C_6$ | 13 | 99 1 | 16 | 1 10 | 103 |
| green | $C_5$ | 29 | 99 1 | 50 | 1 03 | 100 |
| Columns split at 17 ml | $C_4$ | 18 | 99 1 | 20 | 0 91 | 99 |
| Alphamine | $C_3$ | 40 | 9 1 | 28 | 1 31 | 100 |
| red *R* | $C_2$ | 70 | 9 1 | 100 | 1 44 | 101 |

* Equilibrated with one-tenth volume of water

The results obtained from a typical fractionation are given in Table 2 Octanoic and heptanoic acids are not separated, and the separation of heptanoic from hexanoic acid is incomplete (80 per cent) Each column may be used several times

Further details, together with a description of the distillation method and the extraction of acids into chloroform-butanol, will be published elsewhere

We are indebted to the National Research Council of Canada, and to Swift and Co , for financial assistance

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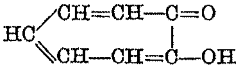
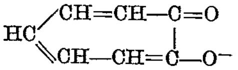
## Tropolone

THE existence of a new type of aromatic ring system, tropolone (I), was first postulated[1] to account for the chemistry of stipitatic acid, and the occurrence of this ring system in a variety of natural products has now been established[2] Various derivatives of tropolone have been synthesized[3], and recently three independent syntheses of tropolone have been described[4] Since it is evident that its chemistry will soon be investigated in detail, it seems of interest to see whether its behaviour can be predicted theoretically before such experimental evidence is at hand



$$HC\begin{array}{l}\diagup CH{=}CH{-}C{=}O\\ \qquad\qquad\quad\;\; |\\ \diagdown CH{-}CH{=}C{-}OH\end{array}$$

I



$$HC\begin{array}{l}\diagup CH{=}CH{-}C{=}O\\ \qquad\qquad\quad\;\; |\\ \diagdown CH{-}CH{=}C{-}O^-\end{array}$$

II

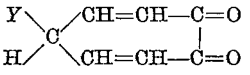
Calculations of energy-levels in the symmetrical anion (II) derived from the acid (I) have therefore been effected, using the standard molecular orbital method This method is not always very successful with heteroatomic systems such as (I) in which mesomerism involves charge separation , but symmetrical cyanine-like ions such as (II) seem more favourable[5] The additional parameters involved were given values which seem appropriate to such ions , the coulomb term of oxygen relative to carbon was set equal to β, and the C—O resonance integral to $\beta\sqrt{2}$, where β is the usual C—C resonance integral The coulomb terms of carbon atoms separated by $n$ bonds from oxygen were given the value $(0\ 4)^n\beta$, following Branch and Calvin[6] and McGowan[7] (cf Dewar[8]) The effects of the two oxygen atoms were taken to be additive

*Resonance-energy* The calculated resonance-energy of (II) is 3 15 β, or 57 kcal , that of (I) will presumably be about 10 kcal less Tropolone should therefore have a resonance-energy comparable with that of benzene and probably somewhat greater This calculation supports the earlier qualitative arguments that the ring system (I) should show aromatic properties

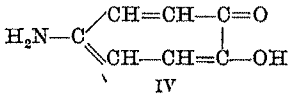
*Light absorption* The calculated excitation energies for the first four transitions are 0 99, 1 00, 1 66 and 1 67 β , and the value of $\beta_{\text{spec}}$ for related ions[5] is 73 2 kcal Tropolone should therefore show double maxima in alkaline solution at about 390 and 235 mμ Tropolone itself, by analogy with other similar compounds, should show similar absorption, but with the 390 mμ band weakened and shifted slightly to higher frequencies According to Cook *et al* [4], the observed spectrum of (I) in alcohol showed maxima at λ = 352, 320, 237 and 228 mμ , while Doering and Knox[4] found maxima at λ = 392, 368, 327 and 235 mμ (solvent not stated) The agreement with theory is unexpectedly good and the extra band found by Doering and Knox at 392 mμ may well correspond to the ion (II), particularly if their solvent was water The absorption spectra of puberulic and stipitatic acids (Todd *et al* [2]) are similar

| Type of transition state | | ΔE/β | | |
|---|---|---|---|---|
| | | Electrophilic | Radical | Nucleophilic |
| Tropolone | *ortho* | 2 564 | 2 466 | 2 368 |
| | *meta* | 2 686 | 2 406 | 2 126 |
| | *para* | 2 086 | 2 302 | 2 554 |
| Phenol | *para* | 2 178 | | |

*Orientation of substitution* When proper allowance is made for the change in electron affinity of carbon atoms due to the inductive effect, it is no longer legitimate to relate rates of substitution to charge distribution , and the most reliable procedure[8] seems to be to calculate the relative π-electron energies of the various possible quinonoid transition states, for example, (III) Such values are given in the accompanying table, the quantities ΔE being differences in total π-electron energy between the transition states and (II) A value for electrophilic *para* substitution in phenol is also given (The positions in (II) are termed *ortho*, *meta* and *para* by analogy with phenol )



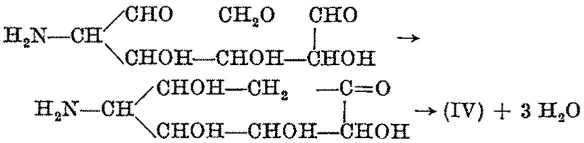
III



IV

These results suggest that electrophilic substitution in tropolone should take place almost exclusively *para*, radical substitution mainly *para*, and nucleophilic substitution—if it can be observed—*meta* Electrophilic substitution should occur with about the same ease as in phenol The orientation of substitution in tropolone is not yet known, but it does couple with *p*-toluene-diazonium salts (Cook *et al* [4]) Reduction of such azo compounds should give *p*-aminotropolone (IV), a compound which may show interesting pharmacological properties since it is the tropolone analogue, and an isomer, of *p*-aminobenzoic acid

In this connexion it is conceivable that (IV) may be a precursor of *p*-aminobenzoic acid, the conversion of tropolones to benzenecarboxylic acids being one of their characteristic reactions , and that the biogenesis of other benzene derivatives may take place through intermediate tropolones Various biogenetic schemes for tropolone can be suggested, of which the most attractive seems to be oxidation of a hexose to a dialdehyde, followed by condensation with formaldehyde and dehydration , and such a reaction with glucosamine would give (IV)



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[1] Dewar *Nature*, **155**, 50 (1945) For convenience, classical structures have been used throughout this note

[2] See Corbett, Johnson and Todd, *J Chem Soc* , **6**, 147 (1950) London, Ann Rep Chem Soc , **45**, 187 (1948)

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[4] Cook, Gibb, Raphael and Somerville, *Chem and Indust* , 426 (1950) Haworth and Hobson, *ibid* 441 (1950) Doering and Knox, *J Amer Chem Soc* , **72**, 2305 (1950)

[5] Dewar, *J Chem Soc* , 2329 (1950)

[6] Branch and Calvin, ' The Theory of Organic Chemistry" (New York, 1946)

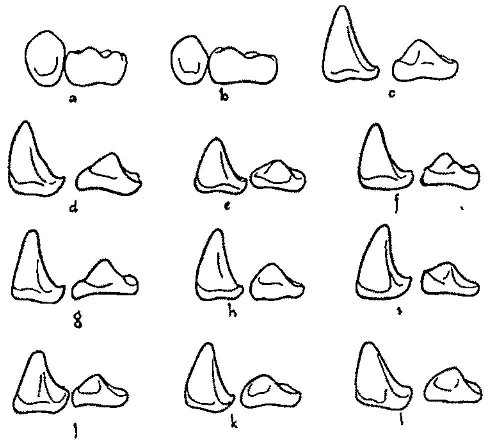
[7] McGowan, *Nature*, **159**, 644 (1947) , *Chem and Indust* , 632 (1948)

[8] Wheland, *J Amer Chem Soc* , **64**, 900 (1942) Dewar, *J Chem Soc* , 463 (1948)

## South African Fossil Hominoids

IN a letter published in *Nature*[1], Prof S Zuckerman stated categorically that the lower milk canines of the fossil Australopithecinæ found at Taungs and Kromdraai (*Australopithecus* and *Paranthropus*) do not differ "in shape and dimensions, relative and absolute", from that of the chimpanzee It appears, however, that this statement was based only on the three overall dimensions of height, length and breadth in a series of fifteen specimens[2] We have now repeated our previous comparative studies on fifty immature chimpanzee skulls and have confirmed that the milk canine in this series presents a morphological pattern very different from that of the South African fossils

In the accompanying figure are shown scale drawings (natural size) of the medial aspect of the milk canine and first milk molars of (*a*) *Homo sapiens*, (*b*) the australopithecine specimen from Kromdraai, and (*c*–*l*) those of ten young chimpanzees taken at random from the series of fifty, excluding six which were classified as grossly distorted by advanced wear, but including those "slightly" or "moderately" worn The Kromdraai milk canine is practically unworn,



and that of the Taungs skull belongs to our category of "moderate wear". The drawings make clear a few of the morphological features in which the chimpanzee canine differs from the Kromdraai specimen, and similarly from that of *Homo*. These features (which are uniformly present in all the canines of our series) include a conical and sharply pointed crown projecting well above the level of the molars, a concave posterior border extending down to the cingulum, and an approximately straight and horizontal internal cingulum which extends back to form a heel (or talonid) projecting beyond the level of the rest of the crown. The maximum width of the canine in all cases also exceeds that of the first milk molar. By contrast, the Kromdraai and modern human canines are spatulate with a flattened medial surface, relatively short and bluntly pointed, their posterior borders above the level of the cingulum make contact behind with the first milk molar, and their transverse width is small relatively to that of the latter. It may further be noted that in the Kromdraai specimen (as is commonly the case in modern man) the anterior border of the canine makes direct contact with the lateral incisor; in none of the chimpanzee series is this the case. Incidentally, the illustration also makes clear the marked contrast in shape and structure between the first milk molars of the chimpanzee and those of *Paranthropus* and *Homo*.

The overall dimensions of height, length and width by themselves can scarcely permit a comprehensive statement that the shape of one tooth does not differ from another. This, of course, applies to the permanent as well as the deciduous teeth. However, if measurements are carefully selected for their relevancy in testing the obvious differences in shape observed on direct visual comparison, these differences can, if necessary, be expressed metrically. The following percentage ratios are here recorded as examples: in the list *C* refers to the ranges of variation in our chimpanzee series (with means and standard deviations in brackets), *K* to the australopithecine milk dentition found at Kromdraai, and *T* to the Taungs skull: max. a.p. length of upper half of canine/total height of canine: *C*, 42–62 (52·0, 5·5); *K*, 78; *T*, 100; max. width of upper half/max. a.p. length of upper half: *C*, 82–111 (98·6, 8·2); *K*, 71; *T*, 65; max. a.p. length of upper half of canine/max. a.p. length at level of basal cingulum: *C*, 56–72 (63·3, 4·3); *K*, 116; *T*, 126; max. height of canine/max. height of first milk molar: *C*, 155–215 (180·7, 14·0); *K*, 130; *T*, 129; max. height of canine/max. height of second milk molar: *C*, 185–268 (219·2, 21·4); *K*, 108; in the Taungs skull the second milk molar is too severely worn down by attrition to obtain this index.

The details of these and other metrical data will be published *in extenso* elsewhere (together with data on the permanent dentition which demonstrate similar contrasts between the Australopithecinæ and the anthropoid apes). They could, of course, be multiplied if this were really considered necessary; but by themselves they appear to show conclusively that the australopithecine milk canine is certainly much more hominid in its shape and proportions than any chimpanzee in our series of fifty skulls. If, however, a chimpanzee milk canine is known in some other series, which presents a total morphological pattern made up of a combination of hominid features comparable to that of the Kromdraai tooth, may we be informed where this unique specimen is to be seen? In this connexion, it is to be noted that at least four excellent specimens of the deciduous dentition of the Australopithecinæ are now known, and in all of them the milk canines present general hominid characters (though, of course, showing certain differences in detail).

I am indebted to Dr. L. H. Wells, of the Witwatersrand University, and Mr. J. T. Robinson, of the Transvaal Museum, for checking measurements on the original specimens from Taungs and Kromdraai. I am also grateful to Mr. D. J. Finney, lecturer in the design and analysis of scientific experiment at the University of Oxford, for his advice in the analysis of the statistical data.

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University Museum, Oxford.
Sept. 23.

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[1] Zuckerman, S., *Nature*, **166**, 158 (1950).

[2] Ashton, S. H., and Zuckerman, S., *Phil. Trans. Roy. Soc.*, B, **234**, 485 (1950).

## Emanating Power and the Age of Complex Silica Gels

PARCHOMENKO[1] demonstrated that, when mixing silica gels with electrolytes of some metals such as magnesium, manganese, cobalt and nickel (with iron always present) by precipitating their chlorides with sodium silicate, compounds can be prepared which are highly absorbent for radioactive salts, and owing to their large colloidal surface give off radon nearly quantitatively.

One of us[2] examined the emanating power of these complex silica gels under different conditions of dryness and age up to 45 months and found that drying for 3–5 hr. at 120° C. or by laboratory air with the relative humidity 20–40 per cent had little effect. On the other hand, the emanating power decreased considerably when the gel was oversaturated with water, but was regenerated after drying. Some results of these experiments together with recent measurements are summarized in the accompanying table, where the emanating power is given by the relation of radon escaping from the sample to the whole amount of radon developed by it. The note "dry" means samples held only at the normal laboratory temperature; "very dry" means samples heated at 120° C. for several hours. The samples are of yellow-brown colour due to colloidal ferric hydroxide. Nos. 1 and 3 are powders with grains less than 0·1 mm. in diameter; No. 2 is granulated with particles of size 1–2 mm.

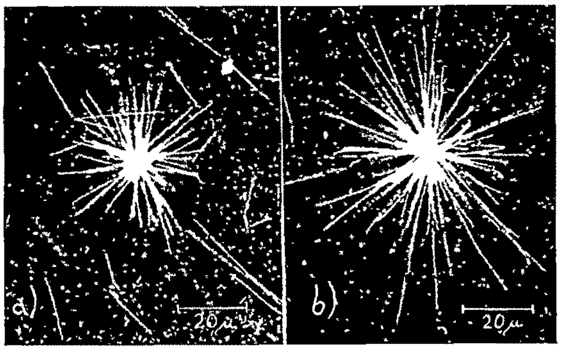
EMANATING POWER OF COMPLEX SILICA GELS

| No and composition of the sample | Date of preparation | Date of measurement | Emanating power | Note |
|---|---|---|---|---|
| 1<br>45 8 $\mu$gm radium (iron + magnesium)-cations | Dec 1, 1934 | Dec 4, 1934 | 97 0 per cent | Dry |
| | | Jan 22, 1936 | 97 0 | ,, |
| | | Oct 4, 1938 | 92 8 | ,, |
| | | Jan 18, 1950 | 89 0 | ,, |
| 2<br>47 3 $\mu$gm radium (iron + magnesium)-cations | Mar 1, 1934 | Mar 30, 1934 | 97 6 | Dry |
| | | Mar 31, 1934 | 40 0 | Moistened with water |
| | | Jan 22, 1936 | 81 0 | Dry |
| | | Nov 30, 1937 | 77 6 | Very dry |
| | | Jan 18, 1950 | 65 0 | Dry |
| 3<br>61 0 $\mu$gm radium (iron + manganese)-cations | Oct 10, 1934 | Oct 30, 1934 | 98 0 | Dry |
| | | Jan 22, 1936 | 92 6 | ,, |
| | | Dec 1, 1937 | 90 9 | Very dry |
| | | Dec 20, 1949 | 66 0 | Dry |

It can be seen from the table that the silica gels lost during the past sixteen years less than half their emanating power in the case of samples 2 and 3, and a few per cent only during twelve years in the case of sample 1 The emanating power is intimately connected with the great inner surface of gels, which in turn depends on the presence of adsorbed water in the inner capillaries of the gel Gels which have lost their internal water crystallize, and their emanating power falls to less than 1 per cent as shown by Hahn[3] for ferric oxide gels From these facts it follows that crystallization progressed very little if at all in sample 1 and markedly in samples 2 and 3, this difference being obviously due to different relations of their contents of electrolytes to the amount of silica gel

Kyropoulos[4] found by X-ray spectroscopy no change in the amorphous structure of pure silica gels five years old, and Sedlitzkij[5] proved that mixed mineral gels resembling montmorillonites in structure, that is, containing magnesium ion and ions of alkaline earths, give, after only four years at laboratory temperature, characteristic X-ray interferences due to partial crystallization Our results are in complete accord with these two results, since our complex silica gels can behave either as pure silica gels when their content of electrolytes is insignificant, as in sample 1, or as montmorillonites, which they resemble in structure, if their content of electrolytes is noteworthy (samples 2 and 3)

We have tried to examine the emanating power of the finest particles of silica gel by the photographic method, using Ilford Nuclear Plates *C* 2 with the emulsion 100 $\mu$ thick A small portion, about 1 c mm of sample 1, was carefully pulverized and dispersed in 2–3 c c of water After 5 min, which was necessary to allow coarse particles to settle, some drops of the liquid with an invisible suspension of the finest grains were put on the emulsion and left there until completely evaporated The emulsion first swells up but becomes again smooth after desiccating, and the grains of silica gel are fairly well fixed in it, forming perfect centres for the alpha-ray stars The plates are developed after one or two days One of the results is reproduced in Fig *a* Even the finest particles with diameter as small as $2\mu$ emit alpha-rays of radium only, showing that the emanating power is maintained even for these small dimensions



Alpha-ray stars from a grain of (*a*) radium-silica gel, and (*b*) radium-barium sulphate

For comparison, the experiment was repeated with radium-barium sulphate and with the same concentration of radium as in the previous case This time (Fig *b*) the star contains also long tracks of alpha-rays from radium C′, though the exposure was the same (two days) as for silica gel With longer exposures even the grains of silica gel will give tracks of alpha-rays from radium C′ because only half of the radon developed escapes into the air and the other half is absorbed by the gelatine of the plate

At least the order of concentration of radium in grains which are centres of the stars can be determined Microscopic examination of the plate gives a mean value of 148 alpha-rays from radium per day for a total volume of the grains equal to 413 $\mu^3$ and for grains of size ranging from 2 to 6 $\mu$. If we use for the transmutation-rate of radium the value of 3 72 $\times$ $10^{10}$ alpha-rays/sec, and for the density of silica gel particles 1 5 gm/c c, then 1 9 $\times$ $10^{-12}$ gm of silica gel will contain 3 1 $\times$ $10^{-16}$ gm of radium and will emit one alpha-particle per day Thus the mass relation, radium to silica gel, equals 1/6,000 $\sim$ 1 6 $\times$ $10^{-4}$, in excellent agreement with the number deduced from the weight of the whole amount of sample 1 (0 277 gm) and its radium content (0 0458 mgm), namely, 1 6 $\times$ $10^{-4}$, that the two figures are exactly the same is, of course, pure chance

Biltz[6] gives for the primary capillaries of silica gels with diameter of molecular dimensions, which are not destroyed by pulverizing, the maximal length of 45 $\mu$, whereas Treadwell and König[7] give 0 26–0 44 $\mu$ only Our photographic check seems to confirm the lower value

It is obvious that the emanation method used by us can be employed for the examination of the ageing process of silica gels In doing so, care must be taken to take sufficiently low concentrations of radium in order to prevent any considerable effect of the decomposition of internal water by alpha-rays which could disguise the true result This effect was of very small order in our experiments Taking Bemmelen's figure[8] of six molecules of water for every molecule of silica in fine pulverized gels, we estimate the amount of internal water in sample 1 to be about 100 mgm Thus, when 50 c c of the explosive gas from the water produced in one day by the action of alpha-rays from 1 gm of radium and supposing that all alpha-rays of the radium contained in the silica gel are absorbed in the internal water only—which, of course, is not the case—we find that, at most, 0 70 mgm, that is, 0 70 per cent of the internal water of sample I, has been decomposed by the alpha-radiation during the 15 years and 2 months of its existence

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[1] Parchomenko, P , *Coll Czech Chem Com* 10, 54 (1938)

[2] Běhounek, F , *Coll Czech Chem Com* , 10, 60 (1938)

[3] Hahn, O , *Ber deut chem Ges* , 67, 159 (1934)

[4] Kyropoulos, S , *Z anorg u allg Chem* , 99, 200 (1917)

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[6] Biltz, M , *Z phys Chem* , 126, 356 (1927)

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## X-Ray and Neutron Diffraction by Graphite Layers

FRANKLIN[1] has shown that an anomalous two-fold increase of the X-ray diffraction intensity is observed for the two-dimensional 10 carbon band She explains this by the fact that the *L*-electrons are not distributed spherically about the carbon nucleus but are concentrated about the centres of the C—C bonds I have obtained further evidence in support of this explanation from X-ray and neutron diffraction measurements

X-ray powder photographs of a sample of artificial graphite show an enhancement of about 85 per cent for the $10\bar{1}0$ line relative to $11\bar{2}0$ and about 80 per cent for the $10\bar{1}1$ line relative to $11\bar{2}2$ Franklin's assertion that this enhancement is not due to a temperature factor, as inferred by Lipson and Stokes[2], is confirmed by quantitative comparison of intensities on photographs at 20° and 500° C These show that the components of thermal vibration are a maximum along the *c*-axis and fall off as cos $\alpha$ to a negligible value in the plane of the carbon layers, where $\alpha$ is the angle between the *c*-axis and the normal to any *hkil* plane The magnitude of the intensity changes found corresponds to a Debye temperature of about 530° K for vibrations along the *c*-axis From these temperature effects even the $11\bar{2}2$ line, of those mentioned above, would be affected by less than 5 per cent

In the case of neutron diffraction, the scattering centres are the nuclei, and not the electrons, so that if Franklin's explanation is correct the neutron intensities should show no anomalies With the experimental arrangements for powder diffraction employed hitherto, the pairs of lines $10\bar{1}0$, $10\bar{1}1$ and $11\bar{2}0$, $11\bar{2}2$ are imperfectly resolved, so comparison has been restricted to the ratios of theoretical and measured intensities of the two pairs These are in agreement to an accuracy of 5 per cent, showing that the anomalous X-ray results appear to be almost entirely due to the asymmetric electron distribution

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July 10

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[1] Franklin, R E , *Nature*, 165, 71 (1950)

[2] Lipson, H , and Stokes, A R , *Proc Roy Soc* , A, 181, 101 (1942)

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## A Scintillation Spectrometer for High-Energy Gamma-Rays

IT has been shown[1,2] that energy measurements with scintillation counters can be made with considerable accuracy with the aid of the 'photo-electron lines' in the pulse-height distribution But the application of this method to energies exceeding 2 MeV is attended by difficulties In this energy-range it is better to measure the energy of the electron-positron pairs produced by the gamma-rays The following procedure was adopted for this purpose Collimated gamma-rays are allowed to impinge upon the sodium iodide crystal of a scintillation counter (Fig 1) The crystal is flanked by two other scintillation counters placed opposite one another

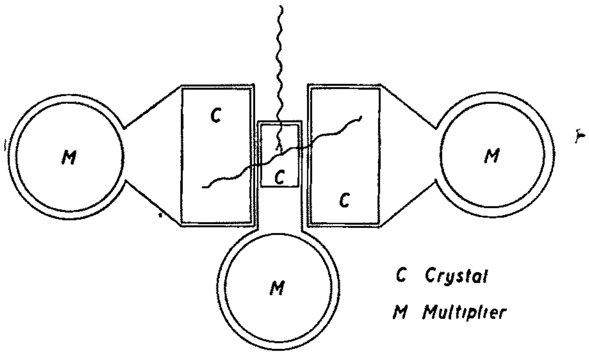

Fig 1 Diagram of the apparatus

The purpose of these counters is to record the two annihilation quanta emitted from each electron-positron pair produced in the central crystal Coincidences between these two counters are used to separate pair-production pulses from other pulses of the central counter Only the former are counted The pulse-height distribution is studied with the aid of a discriminator The apparatus was calibrated by measurements made with the central counter only, in the manner described earlier[1]

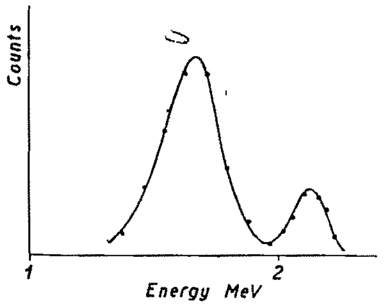

Fig 2 Pulse-height distribution for gamma-rays from antimony-124

Fig 2 shows the pulse-height distribution for the gamma-rays from antimony-124 The energy of the rays (energy of electron-positron pairs plus 1 02 MeV ) is recorded along the abscissa The peaks correspond to the two energies 1 7 and 2·1 MeV The present apparatus is capable of measuring down to about 1 5 MeV The advantage of this method is that every gamma-ray energy gives only one peak in the pulse-height distribution curve

Recently, pair-production peaks have been observed by Pringle, Roulston and Standil[3] and by Hofstadter and McIntyre[4] In those measurements, however, the pair-production peaks and the Compton distributions are not separated but appear simultaneously in the pulse-height distribution

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[1] Johansson, S A E, *Nature*, 165, 396 (1950) *Arkiv for Fysik*, 2, No 18 (1950)

[2] McIntyre, J A, and Hofstadter, R, *Phys Rev*, 78, 617 (1950)

[3] Pringle R W, Roulston, K I, and Standil, S, *Phys Rev*, 78, 627 (1950)

[4] Hofstadter, R, and McIntyre, J A, *Bull Amer Phys Soc*, 25, 16 (1950)

## Haploid Plants of *Solanum demissum*

THE wild hexaploid ($2n = 72$) species *Solanum demissum* Lindl has been widely used in breeding for blight (*Phytophthora infestans*) resistance in potatoes Crossed with cultivated *S tuberosum* varieties (tetraploids with a chromosome number of $2n = 48$) it gives pentaploid ($2n = 60$) hybrids which can be back-crossed by *S tuberosum* An alternative method of breeding has been suggested by Black[1] This consists of crossing *S demissum* with a diploid ($2n = 24$) species such as *S Rybinii* to get a tetraploid ($2n = 48$) $F_1$ hybrid, which is then crossed with *S tuberosum* varieties This latter method appears to have much to recommend it, particularly as Thomas[2] states that, in the hybrid *S demissum* × *S Rybinii* and in the triple hybrid (*S demissum* × *S Rybinii*) × *S tuberosum*, "chromosome differentiation between these related species is not sufficient to affect pairing to any extent" This presumably means that, at least in the triple hybrid, about twenty-four bivalents are formed at meiosis

As part of the potato-breeding programme at the Cambridge Plant Breeding Institute, crosses were made between *S demissum* and diploids such as *S Rybinii*, and between *S demissum* and *S tuberosum*, in order to compare the two methods of breeding As is shown in the accompanying table, in addition to the normal tetraploid ($2n = 48$) $F_1$ hybrids, there were obtained plants with chromosome numbers of 60 and 36 from the cross *S demissum* × diploid The plants with 60 chromosomes are due to the functioning of diploid (24 chromosome) *S Rybinii* gametes The plants with 36 chromosomes are haploid *S demissum* They were typically small plants and had smaller and narrower leaflets than normal *S demissum* They also remained in the rosette stage much longer than the true $F_1$ hybrids, and the one plant which has flowered had much smaller flowers than found in normal *S demissum* Another haploid *S demissum* was obtained in the cross of this species with *S toralapanum* ($2n = 24$)

Meiosis has been examined in one of the *S demissum* haploids It is, of course, what Darlington[3] would call a polyhaploid, having three sets of 12 chromosomes each, and it is not, therefore, surprising that a preliminary examination of 19 cells at first metaphase showed on an average a frequency of 4 74 bivalents per cell The detailed observations were one cell with 2 bivalents, six cells with 3, three cells with 4, two cells with 5, four cells with 6 and three cells with 8 bivalents

| Cross | No of plants with a chromosome number of | | |
|---|---|---|---|
| | 36 | 48 | 60 |
| *S demissum* × *S Rybinii* (H W H) | 2 | 10 | 1 |
| *S demissum* × *S Rybinii* (G S B) | — | 4 | 3 |
| *S demissum* × *S toralapanum* (G S B) | 1 | 2 | — |
| *S demissum* × *S tuberosum* (H W H) | — | — | 14 |

Distant hybridization is a recognized way of obtaining haploids, and it is therefore of interest to note that Dr K S Dodds (see the following communication) has also obtained haploid *S demissum* plants from hybridizations similar to those reported above

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H W HOWARD

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June 21

[1] Black, W, *Proc Roy Soc Edinb*, B, 63, 290 (1949)

[2] Thomas, P T, Thirty-sixth Annual Report, John Innes Horticultural Institution, 11 (1945)

[3] Darlington, C D, "Recent Advances in Cytology" (2nd edit, J and A Churchill, Ltd, London, 1937)

## Polyhaploids of *Solanum demissum*

*Solanum demissum* Lindl ($2n = 72$) has been used at the Commonwealth Potato Collection as the maternal parent in various crosses with cultivated and wild diploid species ($2n = 24$) of *Solanum* The results to date are given in the accompanying table

| Male parent | Number of hybrids | Chromosome numbers |
|---|---|---|
| Cultivated species | | |
| *S stenotomum* Juz et Buk | 2 | 48 (1), 36 (1) |
| *S goniocalyx* Juz et Buk | 1 | 48 (1) |
| *S Phureja* Juz et Buk | 1 | 48 (1) |
| *S Ascasabii* Hawkes | 2 | 48 (1), 39 (1) |
| *S Rybinii* Juz et Buk | 9 | 48 (7), 60 (2) |
| Wild species | | |
| *S Garciæ* Juz et Buk | 1 | 60 (1) |
| *S Parodii* Juz et Buk | 1 | 48 (1) |
| *S platypterum* Hawkes | 1 | 48 (1) |
| *S Ballsii* Hawkes | 1 | 48 (1) |
| *S Soukupii* Hawkes | 1 | 48 (1) |
| *S toralapanum* Cárdenas et Hawkes | 6 | 48 (6) |

The three pentaploids that occur probably arose by the functioning of unreduced gametes from the male parents

Two plants are parthenogenetic polyhaploids of *S demissum*, one with $2n = 36$ and the other with $2n = 39$ They are quite vigorous but are less robust than their maternal parents, and the leaves and flowers are reduced in size Dr Margaret A Keay finds that each polyhaploid behaves to *Phytophthora infestans* as does the particular line of *S demissum* from which it originated, the balanced one is a complete resister, and the unbalanced one an *AC* resister

The unbalanced polyhaploid does not form more bivalents at meiosis than the balanced one, despite the fact that it must be disomic for the three extra chromosomes, the former showed a range of 1–8 bivalents (mean bivalents per nucleus = 4 7, 14 cells) and the latter, one of 3–8 bivalents (mean bivalents per nucleus = 5 6, 9 cells) Thus both hybrids give evidence of some intra-haploid homology of their chromosomes

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Commonwealth Potato Collection,
Huntingdon Road,
Cambridge
June 28

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 6

Society of Chemical Industry, Agriculture Group (joint meeting with the Food Group and the London Section, at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Mr R Barrington Brock "Scientific Aspects of Wine Production" *

## Tuesday, November 7

Royal Institution (at 21 Albemarle Street, London, W 1), at 5 15 p m —Dr F A Bannister "Crystallography in Modern Science, (ii) Crystallography in Geology"

Direction Generale des Relations Culturelles of the Ministère des Affaires Etrangères and the Cultural Relations Department of the French Embassy in London (in the Electrical Engineering Department, City and Guilds College, Exhibition Road, London, S W 7), at 5 p m —Monsieur R Giguet "The Development of Electric Power Supply in France since the End of the War" * (To be repeated on Thursday, November 9, at 7 30 p m at Marischal College, Aberdeen, and on Monday, November 13, at 7 30 p m in the Engineering Department, The University, Glasgow *)

Institution of Civil Engineers (at Great George Street, London, S W 1), at 5 30 p m —Dr W H Glanville Presidential Address

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Dr G S Hartley "Physico-Chemical Problems in the use of Insecticides" *

University of London (in the Department of Civil and Mechanical Engineering, King's College, Strand, London, W C 2), at 5 30 p m —Prof S J Davies "Combustion in Compression-ignition Oil Engines" * (Further Lectures on November 14, 21 and 28 )

Institution of Electrical Engineers, Education Discussion Circle (joint meeting with the Education Group of the Institute of Physics, at Savoy Place, Victoria Embankment, London, W C 2), at 6 p m —Discussion on "Teaching Physics to Engineers"

Royal Aeronautical Society (at the College of Technology, Belfast), at 6 30 p m.—Major P L Teed "Aircraft Metallic Materials under Low Temperature Conditions"

Society of Dyers and Colourists, Manchester Junior Branch (in the Reynolds Hall, College of Technology, Manchester), at 6 30 p m —Mr H B Bradley "The Development of a New Dyestuff"

Royal Institute of Chemistry, Manchester and District Section (at the Municipal Technical College, Bolton), at 7 p m —Dr E Isaacs "Industrial Developments in the Polymer Field over the last Twenty Years"

## Wednesday, November 8

Geological Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Mr Caradoc Williams "Low-Frequency Radio-Wave Propagation by the Ionosphere, with particular reference to Long-Distance Navigation"

Physical Society, Low Temperature Group (joint meeting with Society of Instrument Technology, in the Lecture Theatre, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m —Papers on "The Measurement of Low Temperatures"

British Institution of Radio Engineers, North-Western Section (at Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p m —Mr J C Martin "Radio Navigational Aids"

Manchester Metallurgical Society (joint meeting with the Institute of Metals, at the Engineers' Club, Albert Square, Manchester), at 6 30 p m —Dr B P Dudding "Metallic Materials used in the Construction of Lamps and Valves"

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 30 p m —Papers on "The Significance of Aqueous Vapour Pressure in the Food Industry"

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p m —Mr E F Burford "The Design of Pressure Vessels"

Royal Institute of Chemistry (at the County School, Ridgeway Road, Isleworth), at 7 p m —Dr J G A Griffiths "Rockets and Chemistry"

Society of Visiting Scientists (at 5 Old Burlington Street, London, W 1), at 7 30 p m —Discussion on "Physics and Archæology" (Speakers Prof F E Zeuner, Dr J McG Bruckshaw and Mr E W Jones)

## Thursday, November 9

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S E 5), at 3 p m —Dr H McIlwain "Metabolic Processes supporting the Activities of the Brain" *

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Sir Paul Fildes, F R S "The Development of Microbiology" (Leeuwenhoek Lecture)

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m —Mr E W Barltrop "Labour Problems in the Colonial Empire"

Royal Institution (at 21 Albemarle Street, London, W 1), at 5 15 p m —Dr L R G Treloar "The Physics of Rubber-like Materials" (Further Lectures on November 16 and 23 )

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W C 1), at 5 30 p m —Mr R W G Hunt "A Theory of Luminance Discrimination"

Institute of Metals, London Section (at the Royal School of Mines, Exhibition Road, London, S W 7), at 7 p m —Prof A J Murphy "The Significance of some Less Common Metals"

## Friday, November 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Scientific Papers

Chemical Society, Exeter Section (in the Washington Singer Laboratories, Prince of Wales Road, Exeter), at 5 p m —Dr R S Cahn "Editing for the Chemical Society"

Chemical Society, Newcastle and Durham Section (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5 p m —Dr E J Bowen, F R S "Resonance Transfer of Energy between Molecules" (Bedson Club Lecture) (All Fellows are invited )

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 5 15 p m —Dr W S Feldberg "Chemical Transmitters" * (Further Lectures on November 21 and December 1)

University of Sheffield (in the Firth Hall, Western Bank, Sheffield), at 5 30 p m —Rt Hon Lord Boyd-Orr, F R S "Political Problems raised by Modern Science" (Basil Hicks Lecture)

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St Helens), at 6 p m —Mr S W Ratcliffe "Glass in the Ceramic Industry"

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S W 1), at 6 30 p m —Messrs G Gradfield, L T Perriam, N D G Mountford "Ultrasonic Flaw Detection"

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6 30 p m —Mr F I G Rawlins "Scientific Methods of Examining Paintings"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof Gordon F Hull, Jr "Microwave and Optical Analogues"

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Lecturer in the School of Pharmacy, Plymouth and Devonport Technical College—The Director of Education, Cobourg Street, Plymouth (November 11)

Chemist and Bacteriologist—The Engineer and Manager, Water Department, Town Hall, Reading, endorsed 'Chemist and Bacteriologist' (November 13)

Engineering Assistant (Historical Research) in the Department of Science and Industry—The Director, City Museum and Art Gallery, Birmingham 3 (November 20)

Metallurgists (Experimental Officer grade) for laboratory work in a Ministry of Supply establishment in North-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 626/50A (November 20)

Physicists (Scientific Officer grade) in the Ministry of Supply (Atomic Energy Division) in London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 285/50A (November 20)

Metallurgists at Ministry of Supply Research Establishments near London Physical Metallurgists (Scientific Officer grade) (Ref F 635/50A) with research experience in metallography and a first- or second-class honours degree in metallurgy , Experimental Officer or Assistant Experimental Officer (Ref F 636/50A) with an interest in research on refractories and trained in metallurgy to H N C standard or equivalent—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (November 25)

Scientific Technologist on the Coal Survey headquarters staff in London—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/267 (November 25)

Professor of Physics at Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (November 30)

Assistant Lecturer and Demonstrator in the Chemistry Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W 8

Biochemist, who will also undertake hydrography (chemistry of sea water), and a Marine Biologist (preferably a planktologist), at the East African Marine Research Station, Zanzibar—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S W 1

Cereal Seed Crop Inspector—The Secretary, National Institute of Agricultural Botany Huntingdon Road, Cambridge

Government Analyst in Barbados—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27106/44/50

Head of a new Department of Management Studies—The Registrar, Portsmouth Municipal College, Portsmouth

Junior Research Officer (male) for analytical work, including development and application of analytical methods—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20

Senior Research Officer for work in connexion with marine refrigeration and overseas transport of perishable goods—The Secretary, Refrigerated Cargo Research Council, Cunard House, 88 Leadenhall Street, London, E C 3

Supervising Engineer in the Public Works Department, British Guiana—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27322/161

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# EDUCATION IN WEST AFRICA

MR WALTER ELLIOT has recently said there has been lack of public interest in Great Britain in the two new University Colleges in West Africa established since the end of the War A number of scientific men are aware of the demands which the building up of the teaching staffs of fifty in the Gold Coast and of sixty-seven in Nigeria have made on the British universities, and of the difficulties which are still being encountered in finding staff for the research institutes contemplated in West Africa sometimes in proximity to, if not in association with, the new University Colleges Others, through the reports of the Colonial Research Council, the Colonial Products Research Council and the Colonial Medical Research Committee, are aware of the opportunities for scientific work which such areas present, and the educational problems of these new institutions have been well indicated in the last annual report on the Colonial Territories (cf *Nature*, 166, 201, 1950)

The report* of Dr G B Jeffery to the Secretary of State for the Colonies on his visit to West Africa, December 1949 to March 1950, to study and advise upon a proposal to institute a West African Schools Examination Council not only makes those problems even clearer but also shows how closely related they are to those of Great Britain, and how much the educational institutions of West Africa depend on us for assistance in reaching an effective solution Dr Jeffery goes straight to first principles, considering first the functions of examinations in a developing educational system before attempting to forecast the examinations likely to be needed His analysis of the three types of examination which he distinguishes is not without interest in relation to changes taking place in our own system, where the external examination has become the restraint upon the activity of the teacher on which Dr Jeffery remarks

In this connexion it is important to note the characteristics of the evolution of the school examination in Britain to which Dr Jeffery directs attention, and particularly the steady growth of co-operation between school and university teachers in the conduct of the examinations and more especially in framing syllabuses This co-operation, he points out, has ensured that a certain number of teachers in the universities understand the educational problems which arise in the schools, and has gone far to secure the realization of the ideal of a school examination—that it should follow and not control the development of good teaching in the schools

The second characteristic is the progressive passing of the control of the school curriculum from the examining bodies to the schools, and Dr Jeffery directs attention to the special relationship which is implied between a university examining body and the teachers in the schools taking its examinations The teachers are in a position of trust towards the examining body, which relies upon them for assistance in the progressive adaptation of the examinations to the work of the schools and the educational needs of the pupils, and especially to avoid in their schools the harmful effects which can so easily follow from the misuse of even a good examination For these reasons a university examining body is rightly jealous of the quality and reputation of the schools which are admitted to a school examination conducted by it

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* Gold Coast Colony Report to the Secretary of State for the Colonies by Dr G B Jeffery on a Visit to West Africa, December 1949 to March 1950 Pp 16 (Accra Government Printing Department, London Crown Agents for the Colonies, 1950) 2s

The third type of examination is the 'competitive examination', such as is used for the purposes of appointments in government service or the award of scholarships These examinations differ from the others in both purpose and technique, and Dr Jeffery has observed ill-effects in West Africa from confusing these distinctive functions and attempting to make one examination serve both as a competitive examination and to establish settled educational standards He points out that it would only add to the confusion if any competitive examination which might be established was capable of being used indirectly as a qualifying examination

The determination of the right place of examinations of these several kinds is a matter of great importance in the development of education in West Africa, and Dr Jeffery recognizes that, despite all efforts and intentions to the contrary, the examinations commonly taken by school pupils and young persons in any country profoundly influence educational practice and the public repute of teachers and schools But while African views on education, even those held by some good African teachers, are apt to appear to the outside observer to be utilitarian or even mercenary, he remarks that a school would fail if it did not fit its boys to fill posts in which they can give good service to the community It is a good and not a bad thing that many Africans are prepared to study after their day's work to attain the standard of general education represented by a matriculation examination A deeper understanding of educational values might well lead to the conclusion that other forms of adult education would better meet the needs of some of the pupils of the matriculation classes, and that the purpose of a school should go beyond the mere obtaining of good posts for its boys to an effort to secure that the posts will be fulfilled honourably in the service of the community

Dr Jeffery finds some evidence that this would be admitted by African educationists, though probably the full implications are not yet appreciated His own impression is that we have reached a critical stage in the development of education in West Africa, and therefore a critical stage in the development of African life It is a stage at which it is all-important that high standards should be established, maintained and accepted in every department of public and private life—in politics and public affairs, in commerce and industry, in behaviour, in scholarship, and in craftsmanship The outstanding need of Africa to-day is that more Africans in every walk of life should do their work and carry their responsibilities superbly well according to standards of excellence which West Africans accept as their own

Though Dr Jeffery is concerned primarily with the establishment of good educational standards and particularly with building up a hard core of really good secondary education, his observations have a much wider bearing It is not simply that a mistaken educational and examination system, by causing the curriculum to be excessively concerned with the study of text-books, may provide the country with too many of one type of school-leavers A race of clerks will never be capable of grasping the opportunities which the devolution of self-government offers to them, or even of discharging all the responsibilities which self-government entails The possibility of great achievement depends largely upon the setting up of high standards of work and behaviour, and once those standards are established, provided they can be maintained, there need be no fears as to the speed at which the transition to African responsibility can be made

Dr Jeffery is optimistic on the educational issue He is convinced that the peoples of West Africa have great contributions to make to art and literature, and to the achievements of the human spirit, which cannot be evaluated in terms of money or personal status, or assessed by any examination He is also convinced that a responsibility has devolved upon the African teachers to inculcate standards of moral integrity which are rooted in the life and thought of the people The sincere desire in the West African territories for greater educational facilities is doubtless sometimes exploited by unscrupulous persons, and some of the forms of education which emerge are far from satisfactory It must also be accepted as a fact of the present situation that, whatever examinations are held, the passing of these examinations will be given undue importance in the minds of the pupils and their parents This does not lead Dr Jeffery to conclude that examinations should be abolished or discouraged in West Africa, but rather that the questions of what examinations should be made available and the way in which they can best be adapted to educational purposes should be decided on educational grounds alone by the best available West African educational opinion and experience The proposed West African Examinations Council should be constituted in such a way that it will be regarded as an authority on educational opinion both in West African territories and elsewhere An important part of its responsibilities should be the education of public opinion in relation to examinations, thus meeting the challenge to promote the steady growth of a more informed educational outlook

Dr Jeffery concurs with the opinion of the directors of education that the Council should be a West African Council concerned with questions of examinations in all four territories He does not think that the time is ripe for the institution of examinations conducted entirely on the authority of a West African body, chiefly because such examinations would be unlikely at this stage to achieve the desired measure of recognition in other countries He recommends, therefore, that the Council should, from the beginning, be given the power to conduct certain examinations on its own authority, and that it should be trusted not to exercise this power prematurely It should also be empowered to invite examining bodies in

Great Britain to conduct examinations in West Africa and to accept, in agreement with the examining bodies, administrative responsibility for the conduct of examinations, as well as to advise such examining bodies on the adaptation of their examinations to the educational needs and circumstances of West Africa, without detriment to standards If so requested by one or more of the Governments, the Council should also be empowered to accept responsibility for the conduct of examinations for appointments or awards by Government

The proposed Council would consist of a chairman and nine *ex-officio* and twenty-two appointed members, and would be assisted by eight local advisory committees based at Accra, Bathurst, Cape Coast, Enugu, Freetown, Ibadan, Kaduna and Kumasi Dr Jeffery visualizes the Council as probably responsible for five types of examination a school certificate and higher school certificate examination restricted to candidates from approved schools, examinations for pupils in technical institutes, examinations for pupils in commercial schools, competitive examinations for appointments in Government service, and a public examination open to all candidates

There are other observations of wider interest in the forecast of the examinations likely to be needed which leads Dr Jeffery to this conclusion He notes the different stage of development which secondary education in West Africa has reached compared with the United Kingdom, and the greater degree of maturity required when a student intends to enter a university at a great distance from his home and in a place where the circumstances of life and language are different from those in which he has grown up He suggests that until the supply of graduate teachers is very much greater than at present, such teachers should be used in strengthening the work of the school up to the school certificate level rather than for higher school certificate work He is convinced that if the West African University Colleges and Fourah Bay College are to fulfil their destiny their work must always be based fairly and squarely upon that of the West African secondary schools Moreover, it is essential for their development that the best available African students should go to them for their undergraduate studies It would be disastrous to the prospects of the University Colleges if there were any general acceptance of the idea that the best students proceeded to English universities and that those who are not so good went to the West African University Colleges Dr Jeffery suggests that the Colleges of Art, Science and Technology should in the meantime undertake the work of providing the courses or studies at higher school certificate level to enable students proceeding to universities in the United Kingdom to comply with the new entrance requirements Very careful consideration would, however, have to be given to the danger of the Colleges being thereby deflected from their proper purposes

There is thus much in this report that deserves to be studied by those who are not primarily educationists There are warnings which should be noted by all who are in any way concerned with development and welfare in West Africa or indeed in the African territories as a whole. If Dr Jeffery's report were widely read and studied, it is difficult to believe that some of the well-meaning but bizarre proposals recently advanced, such as that for the teaching of journalism in the Colonial university colleges, would ever have been made The report also provides emphatic endorsement of the value of that intellectual 'lease-lend' between the universities of Britain and of the Commonwealth for which Dr E G Malherbe, vice-chancellor of the University of Natal, pleaded in a recent issue of the *University Quarterly* A large proportion of the teachers, and much of the tradition, of the West African University Colleges must come from Great Britain and, for a generation at least, be continually replenished from this source Few things could contribute more to the establishment and maintenance of the high standards in every department of African life, which Dr Jeffery rightly regards as so vital, as two-way traffic between the Dominion and Colonial universities and those of Great Britain in mature graduates as research workers, as well as lecturers, especially in subjects such as botany, anthropology, entomology, archæology, etc, where the younger countries offer virgin fields to explore What the graduates from the younger country learn of the intellectual freedom and open-mindedness of the old countries can be a vital contribution towards not merely the establishment of educational but also of political standards and traditions.

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# CLASSICAL RADIOACTIVITY AND ITS SEQUENCE

## The Story of Atomic Energy

By Frederick Soddy Pp viii+136 (London Nova Atlantis Publishing Co, Ltd, 1949) 20*s*

THE name of Frederick Soddy is familiar to all men of science as the founder, with Ernest Rutherford, of the theory of radioactive disintegration and as the discoverer of isotopy Specialists in radioactivity will further remember a great number of brilliantly conducted experimental researches in other branches of their science, but only few of the younger generation seem to know anything about his popular books, which were distinguished by literary qualities of an order rarely to be found in the writings of the leaders of science "The Interpretation of Radium" was published in 1909 and eagerly read by thousands, it was revised, enlarged and translated several times and finally replaced in 1932 by "The Interpretation of the Atom", which brought the story up to date, but so great are the advances made since in radioactive research that to-day this book, too, would be only of limited value even if it were still obtainable

It is an event which will give great pleasure to all interested in the history of the discovery and utilization of atomic energy that Prof Soddy, long retired from active research and after years of scientific silence, has devoted himself to the task of presenting once more a complete history of the main discoveries which form the basis of the science of radioactivity "The Story of Atomic Energy" includes much of the material of the two earlier books, but the whole subject has now been rewritten from the point of view reached at the end of the Second World War when the two bombs that finished it demonstrated to the whole world the tremendous importance of atomic energy (The author, by the way, prefers to call this energy, when released, "tomic" energy, since fission and not indivisibility, is its secret )

The scope of the book is very large It deals with all the major discoveries in radioactivity, paying no less attention to the contributions by chemists than by physicists, and therefore refusing to give to this science the narrower modern title 'nuclear physics', it does not start with Becquerel's discovery in 1896, but with the origins of chemistry in Egypt and Greece, and leads the reader through all the successive stages of the development of the atomic theory The author bases his narrative on extensive historical studies and not infrequently disagrees with accepted standards, for example, credit is given not to John Dalton but to William Higgins for being the first to proclaim the modern atomic theory, a statement supported by detailed references to the two books of this "almost forgotten investigator" Dalton's astonishing limitations as a scientific thinker—as revealed in his notes about the constitution of gases and his stubborn fight against Gay-Lussac's results which was the consequence—seem to justify the more modest position allotted to him here In any event, writers of chemical text-books will now have to re-examine this question

Several chapters of the book are devoted to the explanation of physical principles, and the great part theoretical physics has played in the last phases of the liberation of atomic energy is duly emphasized Other passages describe apparatus like the Wilson chamber, mass spectrograph, Geiger counter and cyclotron, and one regrets that the technique of reproducing the half-tone pictures does not do credit to the value of the originals Whatever the topic may be, the personal opinion of the author is always very clearly stated

No one could vie with Prof Soddy in competence to write such a book Not only is he—as he says himself in the preface—"the sole surviving participator in their origin of the discoveries and ideas, which in 1945 culminated in the destructive release of tomic energy", but he could claim with equal justification that he was among the first of the scientific leaders of our age who became interested in the social implications of their work To-day there is widespread discussion on the responsibility towards the community of men of science and particularly experts in radioactivity, but a perusal of Prof Soddy's non-chemical writings of no less than thirty years ago shows how strongly he felt the duty to fight for a better order of things Only the last paragraphs of the book under review bear titles like "The Proper Use of the New Knowledge", "Science and the Community", "The Divorce of Science from Culture, Philosophy and Government", but the spirit forcefully expressed here pervades the whole book It is not written for those who are looking for instruction in the latest discoveries connected with atomic energy—there are other books available for the study of details, but whoever seeks an understanding of all the essential steps by which the harnessing of atomic energy by mankind has been achieved, and who likes to be conducted on his tour by one who for half a century has studied these questions—always completely independent of the views current in science, politics and economics, and frequently opposed to them—will be rewarded by a coherent view over one of the most fascinating developments in the long history of human civilization, an excursion made very impressive by the range of the survey, and by the personality of the guide.

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# ADVANCED TEXT-BOOKS OF ORGANIC CHEMISTRY

### Lehrbuch der organischen Chemie

Von Prof Paul Karrer Elfte, verbesserte Auflage Pp xxii + 1082 (Stuttgart Georg Thieme Verlag, 1950 ) 45 D marks

### Organic Chemistry

By Prof Paul Karrer Original translation by A J Mee Fourth English edition, revised and enlarged in accordance with the eleventh German edition by Dr H V Simon and N G Bisset Pp xxi + 983 (New York and Amsterdam Elsevier Publishing C[illegible] Inc , London Cleaver-Hume Press, Ltd , 1950 ) *57s 6d*

### A Manual of Organic Chemistry for Advanced Students

By Dr G Malcolm Dyson Vol 1 The Compounds of Carbon, Hydrogen, Oxygen and the Halogens Pp xiii + 984 (London, New York and Toronto Longmans, Green and Co , Ltd , 1950 ) 63*s* net

THE first of these volumes, "Lehrbuch der organischen Chemie", is now in its eleventh edition and has become so much an institution among teachers and students of organic chemistry that one notes with some surprise that the first edition was published as comparatively recently as 1927 This work by Prof Paul Karrer is pre-eminent among the text-books of descriptive organic chemistry and is so well known that the new edition and its English translation perhaps need little comment Dr G M Dyson's "Manual" is an entirely new venture, and it is characteristic of his fecundity as a chemical writer and a tribute to his courage that he should have undertaken single-handed a task of such magnitude The volume under review is the first of three, so that it is too early to express an opinion about the scope of the whole work As is the case with Karrer's text-book, Dyson's Vol 1, which compares with it in length, is largely free from a theoretical treatment of the subject, although this is promised for Vol 3

As a comprehensive text-book for advanced students, Karrer's publication seems of a suitable length It includes some mention of all the main groups of organic compounds, and, in general, the amount of detail is sufficient to give the student a clear picture of the chemistry of the substances discussed

The fourth English edition of Karrer's text-book, "Organic Chemistry", corresponds very closely to the eleventh German edition The author's preface to the fourth English edition lists some of the additions and revisions which have been made since the publication, in 1947, of the third English edition These changes, designed to bring the book up to date, are welcome, but are of a minor character, and the fourth English edition is not substantially different from the third

More might have been done to modernize the text of the English edition Thus, although streptomycin is described, there is no reference to chloromycetin or other newer antibiotics Additions to the alkaloid section might have included mention of the synthesis of sparteine and of (±)-tetrahydrodeoxycodeine Also, the section on adrenal cortical hormones might have been brought more up to date, and the table of poisonous substances might have included the fluorophosphonates In some parts the attitude is still that of fifteen or twenty years ago This is exemplified by the structures assigned to aliphatic diazo compounds (p 293) and by the footnote on p 722 In revising the text, opportunity has been taken to improve some of the details of style which were unsatisfactory in the third edition These attempts to give a more accurate English translation of the German text have not invariably been very successful Thus, whereas the third edition refers to the accuracy of Kekulé's formula for benzene having been confirmed, in the fourth edition "accuracy" has been replaced by "justification" Also, the heading "Zucherahnliche Polysaccharide" of the German edition, translated in the third English edition as "Polysaccharides resembling sugars", appears in the fourth edition, without explanation of the term, as "Oligosaccharides" There are many other minor points of criticism which could be advanced, but these do not detract from the general conclusion that these new editions of Prof Karrer's text-book, in German and in English, fully maintain the high standard of excellence, both in content and in production, which has always characterized this work

Dyson's work, when complete, is to be apparently about three times as big The average honours student will certainly not have time to digest such a large text-book I find it a little difficult to foresee what precise purpose the book will serve Although somewhat too elaborate for a student's text-book, it cannot be regarded as sufficiently authoritative to serve as a more comprehensive treatise for the teacher and research worker If one examines in detail sections dealing with subjects with which one is very familiar, one finds numerous instances of emphasis wrongly placed, and the facts are not always accurately recorded The trouble is, of course, that organic chemistry has become so vast that it is beyond the capacity of a single individual to write with authority on all its specialized and intricate branches With this reservation, Dr Dyson's book may be warmly commended as a rich source of information not readily available elsewhere in so compact a form

The book represents in many respects a departure from the usual conventions associated with text-books of organic chemistry Although the chapters are systematic in regard to content, an elementary knowledge of the subject is assumed, and there is no section on organic analysis and the derivation of formulæ There is a full description of the literature of organic chemistry, with advice and guidance on its use In some respects this seems unnecessarily detailed, for eight pages are devoted to reproduction of the entries in "Beilstein" relating to phenylisothiocyanate As might be expected of this author, there is an excellent chapter devoted to a discussion of nomenclature The customary convention of dividing the subject into aliphatic, alicyclic, aromatic and heterocyclic sections is not observed The chapter on hydrocarbons deals with all the groups of these compounds, and this same method of treatment is used in the following chapters, which describe alcohols, phenols and ethers and then aldehydes and ketones, followed by acids and esters Separate chapters are devoted to the terpenes, the carbohydrates and polyhydric alcohols, and the vitamins, hormones and steroids

At first sight it may seem attractive to classify together all compounds of similar function, but in fact it is impracticable to do this The chapter on hydrocarbons is not complete, for the terpene hydrocarbons are treated in a subsequent chapter Also, the present volume does not include, except in passing, references to compounds containing nitrogen or sulphur Hence the second volume, which will presumably include accounts of heterocyclic compounds containing these elements, will need to deal with their derivatives containing the same functional groups which form the subjects of several chapters of the volume now under review It is difficult to trace any real system in the classification used A chapter concerned with substances of biochemical interest deals with chemically diverse types of these, including the heterocyclic vitamins The chapter on alcohols, phenols and ethers is followed by appendixes dealing with flavones, anthocyanins and other plant pigments, photographic developers, and alcoholic fermentation The chapter on hydrocarbons has a very useful appendix on the Friedel–Crafts reaction

I have noted a number of examples of inaccurate or misleading statements The treatment of some subjects is not very modern, and this applies in some instances to the lists of works of reference given at the ends of the chapters A selection of literature references, although not extensive, is a useful feature The index is largely an index of compounds, and contains very few subject headings This serves to confirm the impression that the book tends to be a compilation of data and an extensive series of notes rather than a readable treatise Nevertheless, it may well be destined to take an important place among the advanced text-books of organic chemistry

J W Cook

# SCIENTIFIC RESEARCH IN INDUSTRY

The Organization of Industrial Scientific Research
By Dr C E Kenneth Mees and Dr. John A. Leermakers Second edition Pp ix + 383 (London McGraw-Hill Publishing Co, Ltd, 1950) 42*s* 6*d*

THE thirty years since the first edition of this book was published have seen a vast expansion of industrial research and the firm establishment of some co-operative institutions, both in Great Britain and in the United States, which in 1920 were no more than in the experimental stage That growth is reflected in the expansion of this book from the nine chapters and 175 pages of the first edition to the twenty chapters and nearly four hundred pages of the present volume The text, however, represents essentially a new book It is written in three parts The first, dealing with what are described as "general principles", reviews briefly the expansion of scientific and industrial research in the past three decades, the development of scientific organisation and the broad types of organisation for industrial research This is illustrated by the survey of agencies for the conduct of industrial research, which constitutes the second part of the book

The third part of the book, occupying rather more than two hundred pages, deals with the organisation and operation of industrial laboratories There are chapters on the position and responsibilities of the research department in a company, internal organisation of the laboratory, selection of staff and of programmes, administration or direction of research, transfer of research to production, reporting of results, patenting, publications and library services, financial control, staff problems including salary administration, supplies and services, and laboratory design In this part of the book the authors have drawn largely on their own experience of chemical and physical research, but to some extent also on the replies received from directors of a number of large industrial laboratories in answer to a detailed questionnaire on operating procedures, some further material was supplied by specialists who are not specified

The book is a comparative survey of current practice rather than a contribution to the theory or philosophy of research, and though most of the important factors upon which the successful management and organisation of industrial research are indicated clearly enough, there is little attempt at a critical appraisal of their relative importance Generally, the book is disappointing in that it attempts too much and succeeds in covering no part altogether satisfactorily It does not always make clear where the authors are drawing on their own experience and where they are relying on or quoting from that of others. As a guide to the considerable literature on the management and organisation of research, it is incomplete, and bibliographical references are not only frequently imperfect but also are sometimes omitted altogether The authors would have written a better book had they relied entirely on their own considerable experience or on material they collected by personal inquiry R BRIGHTMAN

## THE FLORA OF CALCAREOUS SOILS

### Wild Flowers of Chalk and Limestone

By J E Lousley (New Naturalist Series ) Pp xvii+254+72 plates (London and Glasgow Wm Collins, Sons and Co , Ltd , 1950 ) 21*s* net

THE aim of the now well-known "New Naturalist" series is to interest the general reader in the wild life of Britain by recapturing the inquiring spirit of the old naturalists and this most recent addition to the series fulfils the objective thoroughly

The author's field for his work—the chalk and limestone areas—gives him a good start, for, as the editors point out, "few types of habitat can boast a larger proportion of rare and beautiful flowers than the limestone—nor more lovely scenery in which to search them out" The rare and/or beautiful can always be depended on to attract the field biologist, and if he has perforce to take some fellow travellers with him he can then depend on the scenery to make up for what the latter might lack in biological enthusiasm

But all readers of this book will surely find "the inquiring spirit of the old naturalists" impelling them to forage on the limestone for themselves To many this might not be possible, nevertheless, any such unfortunate readers can rest assured that what they themselves cannot do, Mr Lousley has done for them, and done it exceedingly well The entire text breathes the air of the field, so though, perforce, to some it might have to be armchair reading it certainly has not been armchair writing Mr Lousley is one of Britain's leading authorities on the flora of the chalk of south-east England, he has also visited most of the other limestone areas of Britain in both north and south

The author opens his text with an account of the inter-relationships of plants and chalk and limestone soils Of particular interest is his discovery that though the various habitats of the calcareous soils of Britain have their own inherent characteristics which are reflected in their floral cover, taken altogether they form a series gradually changing from east to west and from south to north The reasons for the gradual changes, he has revealed as being due to variation in climate and to incidence of the geographical distribution of species The latter is clearly a concomitant of the former

The author does well to begin his detailed descriptions with the North and South Downs and the Isle of Wight, for here he can scarcely be challenged, and, being such an enthusiast, he inspires his readers with his enthusiasm Once this is aroused, there it remains while the reader is taken over all calcareous areas in Britain

The flora of chalk and limestone is well known to be especially rich in rare plants, so here is a great opportunity for an enthusiastic author—an opportunity fully grasped by Mr Lousley Moreover, some of these rareties are beautifully illustrated For example, the military orchid (*Orchis militaris*), fairly well known a century ago, was, by 1914, regarded as extinct in Britain until, in 1947, Mr Lousley rediscovered and fortunately photographed it in colour himself, this excellent photograph is reproduced in the book Again, the grotesque-looking lizard orchis (*Himantoglossum hircinum*) is a very rare and, indeed, capricious plant, but Mr Lousley sought it out and tells us all about it, and Mr Robert Atkinson has supplied a splendid colour photograph of it Then there is the baneberry (*Actæa spicata*), a curious member of the order Ranunculaceae, having small white flowers followed by purplish-black berries This plant is naturally confined to a narrow band across the north of England, elsewhere it seems to have been introduced Again we are presented with a colour photograph These are three examples of the many good things botanical given in this admirable book But, of course, the author has been thorough, consequently the common and less frequent plants are also described and many of them illustrated in colour or black-and-white photographs the like of which have already rendered the "New Naturalist" series so distinguished

Appended to the text are a series of sixteen distribution maps, a list of the vice-counties of Great Britain and the Republic of Ireland, a list of references, a bibliography and an index

The whole work, both text and illustrations, does credit to the author and those who have produced the fifty-two colour and twenty-nine black-and-white photographs It cannot fail to carry out fully its purpose in inspiring the field botanist already familiar with the flora of calcareous soils to delve even more deeply and intensively into the green carpet of the chalk and limestone, in stimulating those who are not so familiar with it to correct the omission and learn about this rather special flora, and in supplying the academic student of botany with a valuable supplementary text L J F BRIMBLE

# OPTICAL INVESTIGATIONS IN MOLECULAR AND IN CELL STRUCTURE

THE Discussions of the Faraday Society are well known all over the world, and they regularly attract distinguished visitors. The latest in the series of these Discussions was held during September 25–28 at Cambridge, and visitors from abroad accounted for nearly a hundred of the three hundred present. Almost every Western European country was represented, and a large group from the United States gave a most interesting international aspect to the whole affair. The first two days of the conference were devoted to a discussion of spectroscopy and molecular structure, the remaining day and a half being concerned with the applications of various spectroscopic and microscopic techniques to the study of cell structure.

## Spectroscopy and Molecular Structure

Spectroscopy is so vast a topic that it can only be dealt with in sections. The most natural beginning—which was actually adopted—is with electronic spectra. In this field it was most interesting to see the changes that have taken place since this subject was last discussed by the Faraday Society. In the first place, all but one of the papers were concerned with relatively large molecules, such as naphthalene or pyridine. This expresses a shift of emphasis away from the well-worked diatomic molecules to that border region where possible relations are being sought between molecular properties and biological activity. It was really most impressive—and encouraging—to see that at last it is becoming possible to characterize the various bands that are observed. Theory plays its part by means of group theory, enabling decisions to be made concerning the symmetries of the allowed wave functions and the permitted transitions. But it goes even further, since many of the most interesting molecular spectra arise from what are technically forbidden transitions. Such transitions, which are usually relatively weak, are made possible by the presence of certain types of vibration, and by certain spin-interactions. The various possibilities can all be listed, so that now, for the first time, we really believe that we can assign some of the transitions in naphthalene and other members of the homologous series. The experimental work of Dr. M. Kasha, in the United States, was the outstanding paper in this section. His analysis of singlet–triplet transitions in substituted benzenes and naphthalenes, in which he has studied the way in which an increase in atomic number of the substituent increases the intensity of these forbidden transitions by breaking down the usual form of spin coupling, and introducing a spin-orbit interaction, will probably become classic.

In the second place, it was interesting to see the greater emphasis, also expressed in the contributions dealing with the infra-red and Raman effect, on intensities. Here is a much neglected tool, the proper use of which is most powerful.

Two other points in electronic spectra deserve mention. The first is that we seem to have passed out of the stage in which exponents of one or other type of theoretical approximation (molecular-orbital or valence-bond) fought hard with the exponents of the other approximation. In certain cases a reconciliation has been effected, with concordant predictions; and in others, we understand the natural liabilities of the methods so much better that we now adopt an attitude of modesty when expressing our conclusions. Quite clearly, theory can help enormously; but it can never dispense with experiment. Secondly, thanks largely to the work of W. C. Price of King's College, London, we are getting on better terms with the so-called Rydberg levels in molecules; here an electron is excited to an orbit of relatively large dimensions, generally lying mostly outside the greater part of the molecule. The energies of these orbits fit into a Rydberg series, very similar to those found with isolated atoms. The quantum defect in the Rydberg expression gives indications of the $s$, $p$, type of the transition, and the constant term gives valuable information about the ionization potential. Excellent progress is being made in understanding both of these, and in correlating them with the size and structure of the molecule.

The conference next turned to discuss the vibrational spectra of small molecules. Here the emphasis is quite different. Very little interest is now attached to the process of assigning frequencies and choosing force-fields; for the tools with which we study infra-red spectra are now fully grown-up. The modern double-beam self-recording spectrometers do in less than a minute what used to require about two weeks; and recent dispersing prisms have greatly extended the range of measurement, while new photocells have completely changed the precision of recording in regions up to 35 μ. As a result the technical problems are almost all solved; what is happening is a gradual transference of interest away from chemistry into physics and biology. In its physical aspects the detailed study of intensities is giving information about the variation of dipole moment with bond-distance, about the changes in configuration that take place on crystallization or other change of state, upon order–disorder phenomena and similar physical problems. In its biological aspects it is enabling us to follow chemical reactions taking place in many kinds of biological material. The most outstanding new applications are in low temperature and in the use of polarized infra-red radiation. Some of these will be referred to later.

It was inevitable that some consideration should be given to the competing claims of microwave analysis and more standard infra-red and Raman rotation–vibration methods for investigating molecular structure. Such a comparison was much stimulated by an excellent review of recent centimetre-wave work by E. B. Wilson. In certain recent microwave work bond distances have been given in angström units to four decimal places. This suggests that there might be some chance of the older and more conventional techniques being abandoned. But as Dr. G. Herzberg (National Research Council, Ottawa) pointed out, there is a quite astonishing agreement, usually to 1 part in $10^4$ or $10^5$, between moments of inertia determined by the two methods. This conclusion, which does not appear to have been sufficiently recognized hitherto, is very reassuring

It is true that microwave measurements are often made with an accuracy about a hundred times greater than the infra-red and Raman measurements But they are made on only one rotational transition (and even then, only on relatively simple molecules), and do not, by themselves, provide sufficient information to correct for anharmonicity of the vibrational motion As a result, they do not allow us to pass from $B_0$ and $D_0$ (constants of the vibrating molecule) to $B_e$ and $D_e$ (constants of the non-vibrating molecule) At present, also, microwaves can only be used with unsymmetrical molecules It was with something approaching relief that the infra-red spectroscopists heard all this, and very happily came to the conclusion that their subject was not yet outmoded To me it seems probable that a combination of the older and newer techniques will prove most fruitful, in which the wider applicability of the one approach is supplemented, at suitable points, by the intrinsically more accurate, though less versatile, character of the other The agreements already reached are a most welcome augury in this direction

Nevertheless, the infra-red exponents had no cause for dismay—at this very meeting they described how there was an almost completely unhindered rotation in zinc and mercury dimethyl , they gave, for the first time, a molecular shape and size to the HNCO molecule, they showed that in $AsH_3$ and $PH_3$ there appears to be no measurable inversion spectrum such as is found in $NH_3$ , they found evidence for two related, but dissimilar, forms of the nitrate ion $NO_3^-$ in metallic crystals, and they discussed the interactions between lattice vibrations and internal vibrations in molecular crystals This is substantial progress, showing that the early technical improvements of Dr H W. Thompson and Prof G B B M Sutherland are continuing to bear fruit

Yet the outstanding paper in this section was due to Prof R Mecke, of Freiburg-im-Breisgau, who reported briefly on a series of about a dozen papers published from his Institute in recent years All were concerned with the 'hydrogen bond' resulting from association of alcohols What was most impressive about these papers was the breadth of the attack made to converge on this one problem Thus dielectric constant measurement, conductivity measurement (showing a small, but quite definite and measurable, proportion of ions due to the migration of the proton from one oxygen atom to another), absolute intensities of a series of overtones of the fundamental frequency of vibration, ultra-violet absorption, and thermal effects all these were made to provide a picture of some of the characteristics of the O—H O bond which could not possibly have been obtained by one technique alone This interplay of various techniques was a valuable and stimulating warning against a too narrow outlook One interesting by-product of this work was that Mecke was able to derive the famous Morse potential function for molecular vibrations This was previously entirely empirical

It is more difficult to comment on the last section of this part of the conference, which was concerned with the vibrational spectra of complex molecules Quite clearly no one is going to try assigning force fields, so that the part played by theoretical argument is very small Much of the work is in the nature of diagnosis, using known frequency charts to infer the existence of certain types of bonding Intensity studies are able not only to show which types of bond occur, but also how many of them there are Thus in saturated hydrocarbons we can estimate the ratio of the number of tertiary and primary carbons , and in unsaturated hydrocarbons the number of double bonds We can also follow the migiation of the double bonds that accompany the chlorination of rubber It is a great pity that the whole basis of this work—the constancy of vibration frequency of individual bonds, or groups of bonds—is still not adequately understood theoretically But some preliminary work has already shown signs of success in sorting out the 'skeletal' vibrations of a long-chain molecule from the 'rocking' and 'wagging' frequencies of individual units along the chain

As an empirical tool, the most noteworthy recent applications of infra-red investigations to large molecules are in the use of polarized radiation , for by controlling the direction of polarization relative to the crystal, we can trace the directions in which, for example, most of the N—H O bonds of a protein system are oriented We can distinguish between folded and extended protein chains, and the process of crystallization can be followed in a most effective manner. The significance of this technique as a tool for investigating crystal structure is that the absorption of radiation is highly specific to certain bonds, and in this way we have a kind of 'probe' that can penetrate easily into the system, by-passing groups of atoms in which we are not interested, and telling us about the orientation of bonds that would otherwise be inaccessible It may be true that there is still need for caution in interpreting the observations, but there is no doubt whatever that an enormous field of application of this type of study to systems of biological interest lies open to be exploited

The Discussions of the Faraday Society have a habit of marking turning-points in their subject Very few people would deny that this was true in the field of electronic and vibrational spectra, as revealed in the recent Discussion at Cambridge

C A. Coulson

## Optical Methods of Investigating Cell Structure

The second part of the Faraday Society Discussion was an intentional departure in subject from anything the Society has previously attempted, and marks a direct recognition and encouragement by the Society of biophysical research In 1929 a Colloid Committee was formed and has been of great value in stimulating and suggesting Discussions This Committee has recently been reconstituted as the Colloid and Biophysics Committee, and has already been responsible for the important meeting to discuss lipoproteins, held at Birmingham last year, together with a number of other locally organised discussions, such as those on nucleic acids, water transport in plants, and the electrical double layer

The Faraday Society, which, since its foundation in 1909, has had such an important influence on the development of the common ground between physics and chemistry, now recognizes at a critical period the borderline subjects associated with physics, chemistry and biology , and it is the intention of the Society to encourage publication in this field In reviewing the Cambridge meeting, I shall not attempt a detailed report of all items of discussion, but rather to give the background and set out briefly the main features of importance which arose

The microscope has always, for obvious reasons, been a fundamental physical tool in cytology During the past twenty years the development of phase-contrast microscopy, the reflecting microscope—and in a wider field the electron microscope—have led to new attempts to understand in a more fundamental way the structure and function of the cell The value of the spectroscope in biology has long been recognized, but attempts to combine microscopes and spectrographs satisfactorily are comparatively new Since 1936, Caspersson and his colleagues in Stockholm have made use of the long-known ultra-violet absorption of the purine and pyrimidine components of the nucleic acids in a detailed study of cells The physical assumptions underlying the accurate appreciation of such methods have not been very well understood, and the time seemed peculiarly appropriate for the discussion under review

Seventeen papers were presented at the meeting , broadly speaking, these fell into three groups Apart from the introduction by the writer, which ranged over the implications of the discussion as a whole, the first group of papers was largely concerned with instruments, their design and proper use in the study of biological material

The design of reflecting microscopes and the performance of these instruments came in for a good deal of lively discussion, started by R Barer (University Museum, Oxford), in which K W Norris and M H F Wilkins, of King's College, London (as authors of papers), and Keohane and Wilfred Taylor took part Two types of reflecting microscope have been developed in Britain The pioneer work on asphérized reflecting objectives has been done by Burch, and it is understood that some of these with 0 65 numerical aperture and 14 per cent central obstruction will be available before long The difficulty of making asphérized surfaces on a large scale probably means, however, that such instruments will always be expensive The other design of reflecting microscope in Britain, using simple spherical surfaces, is due to Wilkins, Norris and W E U Seeds at King's College, London An instrument with a numerical aperture of 0 65 and 35 per cent central obstruction is already commercially available. A third design, due to Grey in the United States, employs mirrors and lenses and is said to have a numerical aperture of 0 72 and obstruction ratio of $\sim$ 30 per cent

The chief point of discussion arose over the appropriate measurement of coma in the simple spherical surface objectives Unpublished calculations by Grey (presented to the meeting by Barer) indicated that the coma-free field would be small The experimental approach of Wilkins and collaborators utilizing a microscope interferometer test, together with study of pinhole diffraction images, appeared to show that a wider field is coma-free and entirely adequate for microspectrometric studies on cells and their components

The discussion on these matters was largely concerned with the question as to whether the reported computations of Grey are equivalent to the stringent experimental tests applied by Wilkins and Norris to their own objectives Coma was defined by Wilkins and Norris as just allowable at any point in the field where the intensity of the second diffraction ring in the image of a point object is equal to the intensity of the first ring on the other side of the maximum Whether such a definition of effective field-size falls within the arbitrary criterion of the Rayleigh limit, presumably only the wave theory of aberrations can show , no doubt this point will be cleared up at a later date The further question as to whether an asphérized Burch objective is suitable for such purposes depends on the allowable degree of 'cobbling' discussed by Wilkins in his paper, and by Keohane at the meeting A number of calculations by Wilkins on the size of object, and other problems, in relation to accurate absorption measurements, were also presented

Infra-red microspectrometry has been attempted on a number of biological objects during the past two years, but the resolving power revealed in the work so far published has been low The interest of the paper by Fraser, in which a 0 8 numerical aperture reflecting microscope was successfully combined with a Grubb Parsons infra-red spectrometer, rested on the very high spectral resolution obtained, which ranged from 8 $\text{cm}^{-1}$ at 3,000 $\text{cm}^{-1}$ to 2 0 $\text{cm}^{-1}$ at 1,000 $\text{cm}^{-1}$ Kletz also reported the design by Bosanquet of a reflecting objective of similar aperture for use in the infra-red

A reminder that macrospectrometric measurements are still of great importance was given in the paper by G H Beaven and E R Holiday (London Hospital), and by E M Jope (Queen's University, Belfast), on ultra-violet absorption spectra of aromatic amino-acids in proteins and related compounds The absorption spectra obtained by the logarithmic cam technique were extremely fine

The use of microspectrographic methods in the study of crystals of biological interest was also aptly illustrated in the second group of papers presented by Seeds and Wilkins (tobacco mosaic virus, tyrosine), and M Perutz (Cambridge), E M Jope and R Barer (horse methæmoglobin) , polarized ultra-violet light was used in all these investigations, and Seeds also described the design of a low-temperature stage for the reflecting microscope

A Engstrom (Institute for Cell Research, Stockholm) described work on the investigation of a number of tissues by his now well-known and elegant X-ray absorption technique, which allows of the accurate estimation of sulphur, phosphorus and calcium Work on the much more difficult problem of estimating carbon, oxygen and nitrogen is in progress Thorell gave an account of a single-beam recording microspectrograph, working in the short wave-length visible range, for the study of end cellular hæmoglobin synthesis H Hyden (Goteborg) presented studies on human nerve cells in relation to the yellow pigment in the cytoplasm, which is at present thought to be a pterin

These papers, and the remaining ones by H G Davies and P M B Walker (King's College, London), B Commoner (Washington University), Catchpole (University of Chicago), and Bradfield (University of Cambridge), brought out several features of interest. The enthusiastic application of microspectrometric methods which has taken place since the War has perhaps led to the view that such methods could give, unaided, unequivocal answers to many fundamental questions, such as those involved in the relations of nucleic acids to protein synthesis Such problems are essentially dynamic in nature, and it is unlikely that solutions will be obtained by static methods alone It was refreshing to find all workers thinking very critically concerning the choice of biological material likely to lead to the most valuable results On one hand, there is the clear-cut geometry of the epidermal hairs of plants such as *Coleus*, discussed in the elegant work of Commoner , on the other, sections of pathological tissue Intermediate between these extremes are tissue-culture preparations such as those used by Davies and Walker. The paper by Davies brought out very clearly the problems of ultra-violet dosage of living cells, and a film shown by Walker demonstrated the effects of continued dosage on the nucleus and cytoplasm. So far as one can judge at the present time, there is just as much danger in the indiscriminate use of qualitative ultra-violet photography as there is in over-stressing the quantitative determination of metabolites by microspectrometric methods. The effects of fixatives on the biological material are as yet only rather vaguely apprehended, and it was interesting to note the measurements of Engstrom using the X-ray absorption method, which demonstrated in certain instances that the use of formalin caused a decrease in mass of tissue, while the use of Carnoy led to an increase. Freeze-drying left the tissue unchanged in this respect.

The ripples which have spread from the pioneer work of Caspersson have now affected many groups in all parts of the world, and perhaps the most significant result of the Discussion lies in the healthy critical attitude adopted by all to the use of microspectrometry in biology. The results of this will, of course, only become apparent in the future. On the other hand, it is clear that the present time is bringing forward new and improved optical methods for the study of microscopic objects, biological or otherwise, and important results are already being obtained on virus nucleoprotein and crystals of biological relevance. The discussions also made it clear that fundamental progress in all these fields can best arise from the close collaboration of physicists, chemists and biologists, in the focusing of many methods and techniques on the problems which arise.

J. T. RANDALL

# POPULATION STUDIES OF GREAT BRITAIN

VOLUME 2 of "Papers of the Royal Commission on Population"* comprises more than a dozen reports and papers of the Statistics Committee. Although all deal with related topics each is largely self-contained, so the publication is not intended to be a unified contribution to demography.

In studying the occurrence of events in a population by statistical methods, a fundamental principle must be observed if the most efficient use is to be made of the data. The principle is, in brief, that as much concomitant information shall be available about individual members of the population who do not experience the events as about those who do. This principle is often met in practice by choosing a suitable random sample of unaffected individuals for study as a control group. In demography, however, the procedure is to relate the numbers of persons experiencing the events to the appropriate population among whom they arise. In either case, any concomitant information which is available for those experiencing the events, but not for members of the control group (or for the whole population), is of limited statistical value.

The lack of a census for Great Britain in 1941 meant that the extensive information on fertility, obtained since July 1938 at birth and death registration, could not be related to equally comprehensive population statistics. The difficulty was partly met by unpublished population estimates by age, marital status and duration of marriage, which were supplied to the Statistics Committee by the General Register Office; but even so, the analysis of fertility statistics could not be as complete as was desirable, and those analyses which were made must have a considerable margin of error. It might have been expected that one of the first uses of the 1946 Family Census would have been to remedy these deficiencies, at least for the female population. It is therefore most puzzling that no such use of the Census material is even considered in the present volume, although, apparently, the necessary basic tabulation was made. In particular, it is very regrettable that, two years after the Census was taken, the research assistant of the Statistics Committee, Mr. J. Hajnal, had to embark upon an extensive study of reproductivity with only the Registrar General's approximate, and incomplete, population estimates. This inevitably restricts the scope of Mr. Hajnal's important contribution to demographic methodology.

Despite these imperfections, the fertility analyses do demonstrate beyond doubt the phenomena of 'postponement' of births and the subsequent 'making-up' which are characteristic of marriages in the period 1940–47, as compared with 1938 and 1939. The beginnings of the process can be discerned for first and second births by the end of 1943. It is shown, too, that the total number of legitimate births in the years 1939–47 was similar to the number which would have been expected if the 1938 figure of 1.93 births per marriage had persisted throughout those years. In other words, the made-up births approximately equalled those postponed. The discovery of this pattern underlying the fluctuations in birth- and marriage-rates during the War years is of considerable demographic and sociological interest.

The Family Census, which was taken in January–February 1946, was based upon a 10 per cent sample of women throughout Great Britain who were or had been married. Although no compulsion could be exercised, at least 87 per cent of the women in the sample responded. Various indirect tests showed that an unduly high proportion of those who did not respond must have been childless, and the results have been suitably adjusted. The preliminary report contained in the present volume gives a clear account of the practical aspects of the Census procedure, from the necessary organisation to the methods of adjustment and analysis. It also presents provisional results concerned with 'family size' (which means here the average number of live births per woman after a certain duration of marriage). It is not made sufficiently clear that these figures refer (naturally) only to those women who have survived to the Census date. There is good reason to suppose that mortality (and perhaps migration) is correlated with fertility—certain forms of cancer are well-known examples—and this may introduce a bias in the absolute figures which could be substantial for the earlier cohorts of marriages. However, the trend shown by the Census results is unlikely to be seriously misleading, and this brings out a second main point of demographic interest, namely, the recent stabilization of family size in Great Britain after a decline lasting for more than half a century. Despite the violent war-time disturbances in birth- and marriage-rates, the family size after ten years of marriage (which is a good indication of complete fertility) is reasonably constant for women who were first married in each of the years from 1927 to 1938 Mr Hajnal's analysis of birth registration statistics confirms this

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* Papers of the Royal Commission on Population. Vol. 2: Reports and Selected Papers of the Statistics Committee. Pp. viii+422. (London: H.M. Stationery Office, 1950.) 8s. net.

The Statistics Committee is evidently, and rightly, impressed by these findings The stability of family size for marriages contracted in the twelve years before the War, together with other considerations, leads the Committee to attach much importance to 'family size' as a statistical concept in the study of reproductivity But the equivalence, during the period 1939–47, of the made-up births to those postponed is an encouragement to endow the same phrase with a more literal, sociological meaning, and to suggest that a certain total size of family may be a fundamental objective of the individual marriage The hypothesis is undeniably attractive, and so there is a real danger that it may be accepted uncritically as the only valid explanation of the statistical facts It has been shown that married couples reacted to one set of environmental circumstances by restricting births, and to another by bearing children more freely Just because one process balanced the other over a certain period of time, it does not necessarily follow that married couples as a group were exhibiting a fixity of purpose with regard to the ultimate size of their families Still less can any conclusion be drawn concerning the individual marriage To proceed from the general to the particular can be as dangerous as the reverse

It is of interest to compare the experience of the two World Wars Family size was stable at all durations of marriage above eight or nine years for those marrying for the first time in each of the years 1915–20 The birth statistics during 1914–22 show the characteristics of postponement and making-up, but the latter process was far from complete It is already apparent that the recent pattern is distinguished by the stability of the average family size of pre-war marriages, and by the completeness of the making-up of births Viewed as a more intense manifestation of similar processes, however, recent events suggest that there will be a rise in average family size for those married during the War, and possibly a decline for those married since It cannot be assumed that the stability, which is at present apparent, is evidence of future stability, and the Statistics Committee makes it clear that it is well aware of this

In addition to these striking demonstrations of the value of the methods of analysis permitted by the new statistics on fertility, the Committee devoted much thought to the problem of measuring reproductivity Mr Hajnal's report, although certainly not the last word on the subject (witness the reservations expressed by Mr V P A Derrick and Dr P Stocks), does represent a most important contribution to the understanding of this technical problem The fundamental difficulty in finding an adequate measure of reproductivity is simply that any measure must assume the indefinite continuance of certain demographic features in the population Even if these assumptions are theoretically acceptable, in the sense that they will ultimately ensure a stable population (as well as being in themselves reasonable), other demographic features in the existing population will inevitably alter in the process These changes will make the indefinite continuance of the chosen features less plausible or even improbable. This difficulty applies with particular force to any reproduction-rate involving one sex only Mr Hajnal develops a theory of reproduction-rates based upon marriage and the fertility of marriages, which, although it does not overcome this particular difficulty, simplifies the handling of it He then applies the theory to the derivation of four equally acceptable measures of reproductivity from a given set of marriage and fertility data, in order to specify the range within which 'true' reproductivity will probably lie In view of the recent fluctuations in birth- and marriage-rates, he is unable to set limits for present-day reproductivity closer than 0 83–1 00, but even this suffices to show that, if people continue to marry and have children at the rates prevalent in recent years, the population of England and Wales will ultimately decline

Mr Hajnal also examines the effects of a change in the age of marriage upon other demographic measures such as the birth-rate, this is a particular aspect of the general problem of the interaction of such changes in demographic phenomena The report contains a great deal more than this brief appraisal might suggest, and it deserves close study by all demographers

Several of the papers deal with the problem of deriving projections of the population of Great Britain during the next hundred years As one mortality basis for these projections, a life table was prepared by the Government Actuary's Department to summarize the mortality experience of Great Britain (civilian war mortality excepted) during 1942–44 A non-actuarial eyebrow may perhaps be raised at the description of this table as 'hypothetical', which would scarcely seem to distinguish it from any other life table Surely 'estimated' would have been a better expression Another basis for projection was provided by a series of exponential trend curves fitted to the age-specific death-rates of 1901–45, and produced as far as 1978 A particularly interesting section of this report explores the possibility of using projections based upon the hypothesis that the mortality of each generation is largely determined throughout life by inheritance or early environment

The actual population projections involved postulates of marriage- and fertility-rates and of migration, as well as of mortality, and a wide variety of assumptions was formulated All those on fertility were specific to duration of marriage and not to the age of the mother, as has been customary in the past. This meant that marriages had to be projected as a first step towards the projection of births The whole process was facilitated by dealing throughout in five-year age groups, and projecting five years at a time with mortality, marriage and fertility assumptions expressed in life-table form Altogether, sixteen projections were made with various combinations of assumptions, and the detailed results occupy more than sixty full-page tables There is plenty of material here for anyone anxious to discern the relative influences of possible mortality, fertility, marriage-rates and migration upon the future course of population in Great Britain

Finally, the Statistics Committee makes a number of practical recommendations to the Royal Commission It points out the need for census data on fertility to be obtained regularly, and suggests modifications and extensions of the existing registration procedures to facilitate adequate demographic analyses Its original hope was that a Family Index might be instituted, which would collate fertility information for each marriage throughout its course on a central 'family card' The Registrar General indicates the difficulty of maintaining such an Index with any accuracy, and rejects the proposal, mainly on the ground that, although the Index would be additional to periodic fertility censuses, it would not yield much additional information The Committee further recommends certain internal changes in the General Register Office of England and Wales to strengthen its status as an instrument for the study of population statistics It considers that demographic statistics should be available for Great Britain as a whole, and not only for its separate parts, and asks that arrangements shall be made for the production of detailed statistics for the whole area In this connexion, the present volume contains a series of tables of demographic statistics for Great Britain, in some instances covering a period of more than a century, and compiled principally from the reports of the Registrars General IAN SUTHERLAND

# THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

## By PROF F J M STRATTON, O.B E, F.R S

General Secretary

IN 1946 the first General Assembly after the War of the International Council of Scientific Unions was held in London The desire to renew and invigorate international co-operation in the various sciences after years of enforced isolation was strong on all sides, and a valuable ally to active development was represented in Dr Joseph Needham, head of the Natural Sciences Division of the United Nations Educational, Scientific and Cultural Organisation He was the herald of generous financial aid to the Council and its Unions by means of grants-in-aid from Unesco, totalling each year some 200,000 dollars These have assisted international gatherings and movements of younger scientific workers, by contributions towards travelling expenses, and also publications and the rehabilitation of scientific stations of international standing It was no doubt due to the fact that international science was already so well organised in many branches that a good case could be made out from the start of Unesco for grants-in-aid that would usefully be spent in bringing together in friendly conference representatives of many countries—one of the best ways of forwarding peaceful relations among the nations

Some of the well-established Unions—Astronomy, Geodesy and Geophysics, Chemistry and Radio-Science—quickly returned to their former activities on well-established lines To others—Physics, Biological Sciences and Geography—came a new lease of life and greatly enhanced activity. Fresh applications for the admission of new unions soon came along, and within a year three were admitted by the Council—Unions of Crystallography, Theoretical and Applied Mechanics, and History of Sciences. Some opposition was offered to the acceptance of new unions in rather specialized fields, but the view that we should feel our way experimentally in the fluid state of affairs following the War prevailed Two classes of unions now exist, namely, General Unions, covering a wide basic field, and Specialized Unions

The whole policy of admission of new unions is at present under review There are two conflicting views One is that to have too many unions would make the whole organisation unwieldy and would lay too heavy a burden on the national adhering bodies that carry the chief financial load of supporting the unions and the Council The other is that it is the Council's responsibility to assist the development of science, especially in the newer and rapidly growing subjects, and that so far as possible the Council should cover the whole range of science The difficulties can be partly, but not wholly, met by attaching new bodies to existing unions and by divisions of unions into sections Basically, however, the fact has to be faced that fresh developments must involve increased financial support, and that considerations other than finance must be given full weight in coming to any general decision

The past history of the Council and its Unions has been described in a pamphlet on the Unions prepared by Dr John A Fleming, a past president of the Council, and issued by the Council It gives short historical accounts of the Council and the Unions, details of their publications, statutes, officers, sections and organisation generally, altogether, it gives an impressive picture of the extent to which, in some subjects at least, international co-operation has forwarded the progress of a particular branch of science

One of the newer developments of the International Council of Scientific Unions since 1946 has lain in the formation of joint commissions to cover ground lying between the domains covered by two or more unions, radiobiology and rheology may be quoted as examples In these cases a commission comes especially under one union, its mother union, but members are nominated by the other unions concerned It is anticipated that such joint commissions will in due course be absorbed by the union that turns out to be chiefly interested, arrangements being made for other bodies to be represented in their membership

Another body which has existed under the International Council since 1937 is a Committee on Science and Social Relations This Committee has had to steer its way carefully between political questions, which do not fall within its terms of reference, and idealist statements which lack the desired practical effectiveness No one will deny the great importance of the problems that it has to face, but it must be admitted that, on the whole, the organisations adhering to the International Council are not as actively interested in its activities as its originators had hoped

One difficulty common to the International Council and its Unions is felt more particularly by the Council itself, and that is the need to keep a living contact with the more distant parts of the world Europe, as was natural in 1919 when its predecessor the International Research Council was founded, has been all along its centre of activity its General Assembly has never met outside Europe, and nearly half of its forty-three national adhering bodies are European countries Though the modern ease of travel has brought the countries of the world as a whole nearer together, the greatly increased cost of travel has made meetings in the more isolated countries more difficult to arrange Regional decentralization may be the solution, but there are difficulties in the way of dividing up a fully international organisation, and the right answer may be close co-operation with existing regional bodies, such as the Pacific Science Council

Finally, just a few figures about the International Council at the present moment It has forty-three adhering countries, while the ten Unions have a number of adhering countries ranging from eleven to thirty-seven It has ten Unions and eleven Joint Commissions, of the ten Unions, five, namely, Astronomy, Geodesy and Geophysics, Chemistry, Physics and Biological Sciences, are General Unions, while the other five, Radio-Science, Geography, Crystallography, Mechanics and History of Sciences, are Specialized Unions The International Council is one of a small group of non-governmental international organisations that have formal agreements with the United Nations Educational, Scientific and Cultural Organisation, which recognizes it as providing a natural and appropriate form for the international organisation of science A liaison officer, Dr R Fraser, established at Unesco headquarters, assures close co-operation between the two bodies The president of the International Council is Prof A von Muralt, professor of physiology at the University of Berne, and director of the High-Altitude Research Station on the Jungfraujoch

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# WATER CONSERVATION IN TERRESTRIAL ARTHROPODS

A DISCUSSION on "Water Conservation in Terrestrial Arthropods", arranged by Section D (Zoology) of the British Association, was held in Birmingham on August 31

Owing to the small size and relatively large surface area of most arthropods, water conservation is a matter of vital importance, particularly to those species living in dry environments Indeed, this need is often reflected in the anatomy and physiology of many of their organ systems, for example, in the closing mechanisms of the spiracles, in the digestive and excretory systems and, not least, in the cuticle and egg-shell Since most attention has recently been focused upon the latter topics, it is natural that the discussion at Birmingham should have been devoted largely to the water-protective properties of arthropod cuticle and egg-shell

A general introduction on the cuticle was given by Dr V B Wigglesworth, who recalled the main growing-points over the past ten years The typical hardening and darkening of the insect cuticle which arise from the tanning action of quinones on a water-soluble protein was discovered by M G M Pryor The process, just as in the tanning of leather, has the further effect of rendering the material hydrophobe and receptive to waxes and other waterproofing agents A few years previously, J A Ramsay had pointed the way to further advances in our understanding of waterproofing mechanisms by his work on the cockroach cuticle Among other findings he showed that the evaporation of water from the cuticle does not vary in a linear manner with the saturation deficit but, owing to a change in the physical properties of a waterproofing grease present at the cuticle surface, increases abruptly at a critical temperature of about 30° C This observation was later extended by V B Wigglesworth to other insects Marked specific differences were found, in general, the more resistant the insect to desiccation, the higher the critical temperature These variations were in turn related to the variable nature of the cuticular waxes, which were found to have graded properties when extracted Conclusive evidence that the typical break in the temperature/evaporation curve is indeed due to changes in the properties of the waxes and not to any other component of the cuticle was advanced by J W L Beament, who extracted and deposited the waxes on artificial membranes, the evaporation curves of such membranes showed critical temperatures closely approximating to those of the intact insects from which the waxes were obtained The more rapid passage of water at the critical temperature is probably caused by a disturbance in the alignment of the wax crystallites owing to thermal agitation.

As a result of these and other studies on the mode of action of solvents and abrasive dusts on the cuticle, a new interpretation of epicuticle structure was proposed Shown by the light microscope as an apparently uniform membrane, these indirect methods revealed the epicuticle as composite and built up from four very thin superimposed layers of tanned protein (cuticulin), polyphenols, wax and a cement-like covering substance

Dr J W L Beament next described his more recent work on the waterproofing mechanisms of insect eggs After briefly reviewing the remarkable range in size and shape of different eggs, he directed attention to the fundamental structural characters which render compatible the essential functions of mechanical rigidity and ability to hatch, water-conservation and respiration The insect egg-shell consists of superimposed layers of protein which may be altered by tanning or other processes All these layers are primarily water-permeable Like the cuticle, the shell is made waterproof by the deposition of continuous films of wax or oil, although in some examples an existing layer may become impregnated with lipoid But their arrangement is 'inside out', for the waterproofing layer is usually situated inside the shell and not at the external surface.

Various types of waterproofing systems can be traced In what is perhaps a primitive condition, as exemplified by the tick egg, the wax is smeared on the outside of the egg by a special waxing organ In *Dixippus* and apple sucker eggs, the waterproofing agent is also contributed by the mother and consists of an oily grease incorporated between the layers of the chorion On the other hand, in such typical eggs as those of the blowfly and aphid, the wax layer is internal and is secreted by the oocyte In *Rhodnius* there are two such internal layers laid down at different stages in the development of the egg Dr Beament concluded by describing the formation of the wax layers in *Rhodnius* and in the fruit tree red spider mite, both of which possess waterproofing layers of the double type

It was a particular pleasure to hear Dr E H Slifer, of the University of Iowa, describe her elegant researches on the conservation of water in the egg of the grasshopper *Melanoplus differentialis* Here the main point of biological interest centres around the control of water uptake, since this phenomenon is intimately related to the onset and elimination of diapause The fully formed egg-shell is again a multi-layered structure of great complexity. When the egg is laid, the shell consists of the chorion, secreted by the follicle cells of the mother, and, passing inwards, the primary wax layer and vitelline membrane, both secreted by the oocyte. During the first three weeks of development, further layers, the yellow and white cuticles, are in turn added to the inside of the shell by the secretory activities of the embryo. The yellow cuticle is at first porous over the hydropylar region, but becomes impermeable to water at the three-week stage immediately before the onset of diapause. The passage of water through the shell is controlled by the orderly deposition or dissolution of these waterproofing layers. For one week after laying, the entry of water is prevented by the primary wax layer. This barrier is then broken down and water continues to enter the egg until halted by the deposition of the secondary wax layer associated with the yellow cuticle. At the termination of diapause this is in turn broken down, water again enters the egg and embryonic development recommences.

Widely differing powers of limiting evaporation from the cuticle are also found in other groups of terrestrial arthropods, for example, spiders and ticks. In the latter group, as in insects, these differences have been found to be a reflexion of the nature of the cuticular waxes, which vary in efficiency as waterproofing agents from species to species. Dr. A. D. Lees spoke of the probable ecological significance of such differences. The typical ground habitat in a representative series of ticks ranges from moist hill pastures in temperate climates (the sheep tick, *Ixodes ricinus*) to dry sandy localities in tropical regions (*Ornithodoros* spp.). The ability to resist desiccation is closely linked with the available moisture in the environment; the drier the environment the more resistant the species it harbours. The significance of waterproofing efficiency as an ecological factor limiting spread to new environments was illustrated by reference to two species of *Ixodes* with an overlapping distribution. Owing to its susceptibility to desiccation, *I. ricinus* is prevented from colonizing a relatively dry habitat which is suitable for its better protected relative *I. canisuga*.

The water relations of woodlice, which were discussed by Dr. E. B. Edney, provide several contrasting features. Although they live in a variety of situations ranging from the wet (the littoral species *Ligia*) to the comparatively dry (*Armadillidium*), the rate of transpiration through the cuticle, and particularly through that of the pleopods, is always high in comparison with insects. Moreover, the temperature/evaporation curves in all the species examined bear a linear relation to the saturation-deficit and show no break or critical temperature. This evidence, therefore, favours the view that no waterproofing layer is present in the epicuticle. Nevertheless, rapid transpiration may serve a useful purpose under certain conditions. Measurements have shown that evaporation into dry atmospheres can result in a marked fall in the body-temperature. This mechanism, which would be effective in cooling these animals for short periods up to one hour in duration, may enable woodlice to escape the effects of high temperatures. Compared with the Insecta, however, Isopoda have been unsuccessful land colonizers. Two important factors which have limited their distribution on land are, Dr. Edney suggested, their lack of an impermeable cuticle and their low temperature-tolerance. A. D. LEES

# OBITUARIES

## Sir William Benham, K.B.E., F.R.S.

THE death occurred in Dunedin, New Zealand, of Sir William Benham, who for thirty-nine years was professor of biology (later zoology) at the University of Otago, New Zealand. Born at Isleworth, Middlesex, in 1860, he was educated at Marlborough College, being intended for the Indian Civil Service; but later it was decided that he should study for the profession of analytical chemist. Towards this end he went to University College, London, and it was here that he came under the influence of Ray Lankester, who gave the young student great encouragement and finally directed his steps to zoology. In 1883 he graduated B.Sc. (London) and completed his D.Sc. in 1887, his subject being earthworms. After graduating he was sent by Lankester to Kiel to study karyokinesis under Fleming, who was then the leading authority on this new subject; but Benham's interest remained with earthworms, much to Lankester's disappointment. In 1890 he went with Lankester to Oxford, where he remained as Aldrichian demonstrator until he left for New Zealand in 1898.

Benham's first paper on the testis of *Limulus* was published in the *Transactions of the Zoological Society* in 1883, the problem being set by Lankester, who was at the time interested in the relation of *Limulus* to the Arachnida. Another paper on the complete muscular and skeletal systems of *Limulus* was published before he began his life-work on earthworms. In this he was greatly helped by Jeffrey Bell, of the British Museum, who made available to the young enthusiast a world-wide collection of earthworms.

Although he published more than sixty papers on this group, Benham is equally well known for his publications in other groups. His Part IV of Lankester's "Treatise on Zoology", dealing with Platyhelmia, Mesozoa and Nemertines, is a very valuable book of reference. His account of the British Polychætes in the "Cambridge Natural History", published in 1895, is still the only detailed account of this group in the English language. From time to time he was asked to examine collections of Polychætes—from the *Endeavour* on the Australian coast, from the Mawson Antarctic Expedition and from the *Terra Nova* Antarctic Expedition. Benham was especially pleased at being invited to examine the last, in 1921, although he had been living for so many years in the Antipodes.

In New Zealand he kept up his interest in Chætopoda; but he also described representatives of other groups—Balanoglossids, Hirudinea and Gephyræa, and at the other end of the scale he examined whales, living and extinct. Birds, too, the moa and the *Notornis*, interested him.

Altogether, some hundred and thirty papers were published over a period of sixty-seven years, and some of the figures illustrating these have been reproduced in text-books by English, American, French and German authors. In his retirement he continued his research and kept up a wide correspondence with farmers in connexion with earthworms and agriculture. His last paper, written in his ninetieth year, is now in the press.

Sir William Benham was a most engaging personality, combining an old-world courtesy with authority and breadth of learning. He was an expert lecturer; even those who had heard many and able lecturers were always refreshed by Benham's approach to his subject and his slightly acid touch. He was always at home with his subject, so his discourse was quite untrammelled by nervousness or reserve, and took on an intimate quality which was very appealing In the circle of his friends, Benham's company was prized for its whimsicality and freedom from cant and hypocrisy, while his undoubted histrionic ability made him a raconteur of the first order A man of strong personality and unusual charm, he will be greatly missed by those who knew him

MARION FYFE

WE regret to announce the following deaths

Sir Frank Gill, K C M G, director and vice-president of the International Standard Electric Corporation and other bodies concerned in telephonic communications, past president and honorary member of the Institution of Electrical Engineers, on October 25, aged eighty-four

Dr G A Hankins, director of mechanical engineering research in the Department of Scientific and Industrial Research, on November 2, aged fifty-five

# NEWS and VIEWS

## Nobel Prize for Medicine for 1950

THE Nobel Prize for Medicine for 1950 has been awarded jointly to Dr Philip Showalter Hench, of the Mayo Clinic, Rochester, Minnesota, Prof Edward Calvin Kendall, of the Mayo Foundation, Rochester, and Prof Tadeus Reichstein, of the University of Basel The award can be regarded as a recognition of the work which has been done leading to the dramatic opening of a new field of scientific medical research—that of rheumatoid arthritis and related diseases Early in 1949, Hench, Kendall, Slocumb and Polley (*Proc Staff Meet Mayo Clinic*, 24, 181 , 1949) reported on "the effects of the hormone of the adrenal cortex (17-hydroxy-11-dihydrocorticosterone Compound *E*) and of pituitary adrenocorticotropic hormone on rheumatoid arthritis" This was followed soon after by a report of the effects of compound *E* on rheumatic fever (Hench, Slocumb, Barnes, Smith, Polley and Kendall, *Proc Staff Meet Mayo Clinic*, 24, 277 , 1949) Since then, investigations have begun in centres of research in all parts of the world on the physiological action and the clinical application of cortisone This work is now developing at an increasing rate, limited only by the availability of cortisone, the supply of which on the present scale is due to outstanding team-work in the research institution of a famous pharmaceutical firm

Dr Hench has long been a recognized authority on rheumatic diseases After training in America, he obtained further experience in Freiburg im Breisgau and Munich, and joined the staff of the Mayo Clinic in 1923 The genesis of the discovery of the activity of cortisone is to be found in his belief that an endocrine influence was active in cases of remission of rheumatoid arthritis, for example, in pregnancy The approach of Prof Kendall to this subject has been along biochemical paths He has worked at the Mayo Foundation since 1914 and his interests have been in the field of endocrinological chemistry He was the first to isolate and investigate thyroxine In 1930 he was president of the Association for the Study of Internal Secretions His work on the chemistry of the adrenal cortex is described in a series of papers beginning in 1934, and the isolation of cortisone, then termed compound *E*, was announced in 1936 Prof Reichstein elaborated a synthesis of ascorbic acid in 1933, almost simultaneously with the work of the late Sir Norman Haworth His work on the isolation, determination of constitution and partial synthesis of constituents of the adrenal cortex began in 1935, when he was at the Eidgenossene Technische Hochschule in Zurich The work continued uninterruptedly after transference to the Pharmaceutical Institute at the University of Basel in 1939 and was extended to other groups of steroid compounds, androstane and pregnane derivatives, and, by way of investigation of pharmacologically active plant constituents, to the cardiac glycosides , concurrently, investigations in carbohydrate chemistry were carried out The scientific papers coming from Prof Reichstein's laboratory during the past two decades form a remarkable record of technical and theoretical achievement in a field of complex chemistry

## Philosophy at Birmingham Prof. L J. Russell

PROF L J RUSSELL, who recently retired from the chair of philosophy in the University of Birmingham (see *Nature*, August 16, p 296), had a varied and influential career as a university teacher He read both science and philosophy at Glasgow (which recently acknowledged his mature distinction by the award of an LL D ) and he has never lost his interest in mathematical physics—an interest which determined the direction of much of his work, for example, both his historical investigations, which at one stage focused on Leibniz, and his numerous contributions to the discussion of scientific method In the first flush of the triumph of the new symbolic logic he was able to mediate usefully between the old and the new, and did much to ensure that the new logical notations would be clear and distinct More recently, his theory that some statements usually regarded as propositions are, in fact, 'proposals' has aroused international interest among logicians Such more abstract discussions did not prevent him from taking a keen interest in the problems of contemporary society He campaigned unwearyingly for a more concrete approach to ethics philosophers, he contended, should not shirk the discussion of questions like birth-control, euthanasia, or pacifism Here as elsewhere he had little patience with the 'standard works', and his quest for concreteness led him to make a wide study of social institutions and social anthropology At Birmingham, one of his most successful innovations was a lively course on the logic of the social sciences He never regarded himself as a mere 'Arts' man and his services were often sought in other faculties A selection of his articles is to be published, the publication being sponsored by the University of Birmingham

Perhaps the most many-sided of the professional philosophers of his generation, Russell was always informal and stimulating in his methods His influence extended far beyond the limits of the schools of philosophy which were his immediate concern, and it always promoted freer thinking and wider horizons Fortunately his retirement is due to no incapacity but solely to the passage of the years, and all who know him will expect his coming years to be marked by undiminished activity both in writing and in new fields of practical education

## Fifty Years of Service in Mineralogy: Dr. L J Spencer, C B E, F R.S

MEMBERS of the Mineralogical Society of Great Britain met in London on November 2 to do honour to Dr L J Spencer, formerly keeper of minerals in the British Museum (Natural History) The occasion was the completion by Dr Spencer of fifty years as editor of the *Mineralogical Magazine and Journal of the Mineralogical Society*, an honorary post which he has held since he took over the editorship from Sir Henry Miers in October 1900. The *Mineralogical Magazine* is issued quarterly and contains the Society's proceeding and papers read at its meetings In 1920 the Society commenced publication of *Mineralogical Abstracts* as a separately paged part of the *Magazine* The editor has contributed by far the greater number of all the abstracts published and has prepared topographical and subject indexes every three years The next number of the *Magazine* will be a special one in his honour and will contain papers by distinguished mineralogists from many parts of the world Dr Spencer was eighty in July

## Indian Scientific Liaison Office in London: Dr S. Krishna, C I E.

THE Government of India has appointed Dr S Krishna, lately vice-president of the Forest Research Institute, Dehra Dun, and director of forest products research, to be Indian scientific liaison officer in the United Kingdom Dr Krishna, who was born in 1896, was educated at the Forman Christian College (Lahore), Queen Mary College (London), and King's College (London) He held the professorship of chemistry, University of Punjab, during 1925–28, after which he entered Government service as biochemist at the Forest Research Institute, Dehra Dun He was appointed C I E in 1941 In 1948, he represented India at the Fifth Forestry Conference in London and in 1949 he visited Australia as leader of the Indian Science Delegation

## British Museum (Natural History)

IN the British Museum (Natural History) Mr N D Riley, keeper of the Department of Entomology, has been appointed to be a deputy chief scientific officer, and Mr A W Exell, principal scientific officer in the Department of Botany, to be deputy keeper in the Department Mr Riley entered the Entomological Section of the Department of Zoology in 1911, becoming keeper of the Department in 1932 He served in the Royal Army Service Corps during 1914–19 and was mentioned in dispatches Mr Riley has edited *The Entomologist* since 1922, and has been treasurer and later secretary of the Royal Entomological Society of London since 1939 He is a corresponding member of a number of foreign academies and scientific societies, and is the author of a large number of scientific papers, mainly dealing with butterflies from the systematic point of view Mr Exell entered the Museum in 1924, when he was placed in charge of the Polypetalæ His main work has been on the flora of tropical Africa, and he made expeditions to the islands of the Gulf of Guinea during 1932–33 and in Angola in 1937 He was seconded to the Foreign Office during the Second World War

## United Nations Food and Agriculture Organisation

THE conference at Washington, D C, of the sixty-three member nations of the United Nations Food and Agriculture Organisation, which began on November 4 and is expected to continue for a week, marks the last occasion on which the Organisation will meet at Washington before its move to new headquarters in Rome, scheduled to take place early next year In Rome two new buildings will be occupied, these are under construction by the Italian Government, and the first is expected to be ready in February and the second in October Mr N E Dodd, the director-general of the Food and Agriculture Organisation, has stated that with the disruption of activities caused by the move and owing to the fact that a large proportion of the staff (about 80 per cent of the lower-salaried staff and 40 per cent of the higher grades) will not be going to Rome, the work of the Organisation will be severely hampered during the first half of 1951 at least The conference at Washington, unlike the previous annual sessions, is a special one, limited to the essential financial and administrative matters and other urgent questions which may arise This new departure was decided on at the 1949 conference when, in addition to the resolution for the transfer of the headquarters to Rome, the principle of biennial, rather than annual, conference sessions was also adopted, under this system a full-scale conference is not to be held until the autumn of 1951

## Development of Crawfish Industry in Tristan da Cunha

A PROJECT entailing the commercial development of the crawfish industry of Tristan da Cunha has been undertaken by the Colonial Development Corporation in conjunction with a South African fishery group This will involve the operation of a fishery vessel, equipped with deep-freezing apparatus and deep cold-storage accommodation, to process and transport frozen crawfish tails to Capetown for regular shipment thence to the North American and European markets. In addition, a canning plant will be erected and operated on the Island itself The Tristan da Cunha Development Co, which has undertaken the initial work of investigation, will now be re-organised, and additional finance to a total of £130,000 will be found by the Colonial Development Corporation, which will then have the financial control of the Company The Company has also undertaken the responsibility of supplying both social and medical services to the islanders Altogether this whole project may well be the deciding factor for the continuation of the settlement on the lonely island of Tristan da Cunha, where the community is in a difficult situation

## Eradicating Barberry in the United States

A RECENT bulletin of the U S Department of Agriculture ("Kill Barberry Bushes that Spread Stem Rust to Grains", Farmers' Bulletin No 2014, April 1950) brings new methods to bear upon the time-honoured practice of controlling stem rust of cereals by destroying barberry The use of the modern weed-killer 2,4-*D* is of particular interest, it is used at full strength to paint the stubs of European barberry canes immediately after the bushes have been cut off close to the ground This method ensures that any other valuable plants growing in the vicinity will not suffer Native barberries can be killed off with 2,4-*D* used as a foliage spray Ammonium sulphamate is also used as a control, this substance being applied in dry form to all freshly cut surfaces, a pound being enough to kill several medium-sized bushes Failing either of these chemicals, common salt will kill barberry if applied to the crowns of European plants in sufficient quantity (about 20 lb per square foot of crown) Native bushes will succumb if the salt is merely sprinkled lightly on the ground around the canes

## National Certificates in Applied Physics

A PAMPHLET recently issued by the Institute of Physics describes the purpose, scope and value of the courses leading to the award of national certificates in applied physics It is pointed out that every professional physicist employed in research and development requires two or three technical assistants who need to have a knowledge of the fundamentals of physics and some skill in experimental technique and in making apparatus and instruments It is for these assistants that the certificates are intended They are awarded jointly by the Ministry of Education and the Institute of Physics Study is part-time, extending for the ordinary certificate over three years, and for the higher certificate over a further two years of advanced study, and reaching a standard approximating to that of a university degree at pass standard in the subject Students attend at recognized technical colleges The examinations on which the certificates are awarded are assessed by senior members of the profession appointed by the Institute of Physics Copies of examination papers set in recent examinations are now available and may be obtained from the Institute of Physics, 47 Belgrave Square, London, S W 1

## University of London

THE following have been appointed to University of London readerships tenable at University College in the subjects indicated Mr Michael Abercrombie, embryology, Dr E H S Burhop, physics, Mr J W Whitfield, psychology The degree of D Sc has been conferred on the following B Kassanis (Rothamsted Experimental Station), Dr H O Schild (University College), R Kingslake (Imperial College of Science and Technology), E C Humphries (Queen Mary College), J J D King (King's College Hospital Medical School), and C N Davies (external student)

## University of Leeds

THE following gifts, among others, have been received by the University of Leeds sums not exceeding £4,000 in 1950–51 and £5,000 in 1951–52, from the University Grants Committee, for financial assistance to students taking postgraduate courses in the Departments of Fuel and of Textile Industries, £12,000 (approximately) over three years from the Department of Scientific and Industrial Research to the Department of Botany for research in plant biophysics, £6,000 (approximately) over three years from the Agricultural Research Council to the Department of Botany for new biochemical research, £1,000 from the North-Eastern Division of the National Coal Board to the Department of Mining, an annual sum of £2,000 (less tax) for fifteen years from the Worshipful Company of Clothworkers, for the maintenance or benefit of the Clothworkers' Departments, and a renewal by Imperial Chemical Industries, Ltd, of the covenant for the endowment of fellowships for a further seven years, the value of the fellowships to be increased from £600 to £800 a year Dr J H Western has been appointed senior lecturer in agricultural botany in the University, and the following have been made lecturers in the subjects as indicated A D Greenwood (botany), Dr L Peters (textile industries), Dr A Jowett (dressing of minerals, in the Department of Mining) and Dr D E Nicholson (bacteriology)

## Announcements

THE Committee of the Privy Council for Agricultural Research and Nature Conservation has appointed Dr Norman C Wright, chief scientific adviser of the Ministry of Food, to be a member of the Agricultural Research Council

PROF F A VICK, professor of physics, has been appointed vice-principal of the University College of North Staffordshire The following have been made lecturers in the College Dr R G Evans (biology) and Dr P H Plesch (chemistry)

LORD REITH has been appointed chairman of the Colonial Development Corporation in succession to Lord Trefgarne, whose resignation took effect on October 31

MR D W Bishopp, director of the Geological Survey of Ireland since 1940, has resigned He has now been appointed senior geologist to the Cyprus Government, which is initiating a detailed geological and mineralogical survey, including geophysical research, of the island

THE gold medal of the Society of Dyers and Colourists has been awarded to Dr S. M Neale, senior lecturer in physical chemistry in the College of Technology, Manchester The award was made "For pioneer work in the application of the methods of physical chemistry to the elucidation of the phenomena of dyeing, more particularly of cellulosic materials with substantive dyes"

THE first British Instrument Industries' Exhibition will be held in the National Hall, Olympia, during July 4–14, 1951 Coinciding with the Festival of Britain year, this Exhibition will show scientific and industrial instruments of entirely British manufacture and is designed to increase the export market Further details can be obtained from the organisers, Messrs F W Bridges and Sons, Ltd, Grand Buildings, Trafalgar Square, London, W C 2

THE nineteenth Stephen Paget Memorial Lecture of the Research Defence Society will be delivered by Prof E D Adrian on November 22, at 5 30 p m, at University College, Gower Street, London, W C 1 Prof Adrian will speak on "Experiments on the Nervous System"

THE first Trotter–Patterson Memorial Lecture of the Illuminating Engineering Society is to be given by Dr J W T Walsh, of the National Physical Laboratory, at the Royal Institution, Albemarle Street, London, W 1, on January 17, at 6 p m Dr Walsh will speak on "The Early Years of Illuminating Engineering in Great Britain" The Lecture is open to the public and admission will be by ticket, obtainable from the Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S W 1.

IN the last paragraph of the review, published in *Nature* of October 14, p 620, of Corner's "A Monograph of *Clavaria* and Allied Genera", the comment that only one specimen of a clavaroid fungus has been sent to the Kew Herbarium in the past thirty years is incorrect, for 'Kew' read 'Commonwealth Mycological Institute' In fact, Kew Herbarium, where the group has been studied, has numerous examples of *Clavaria*

# INTELLIGIBILITY OF EDUCATIONAL BROADCASTS*

A B B C experiment in further education, initiated two years ago, included an attempt to trace some of the educational effects of broadcasts to adults. A first step was clearly to ascertain whether, in fact, broadcast speakers were being understood by their audiences Early in 1949 Prof P E Vernon, professor of educational psychology in the University of London Institute of Education, was consulted about the possibilities of measuring the intelligibility of sample broadcasts and also identifying the qualities of a script which make it easy or difficult to understand. A scheme of investigation was drawn up and, with the co-operation of the Army Institute of Education, it was decided to study fifty Forces Educational Broadcasts At the same time the present writer carried out parallel experiments with a number of broadcasts, including three on the subject of science, constructed at different levels of difficulty

American investigators—Lorge, Flesch, Dale and Chall—have attempted to produce formulæ by which one could predict the intelligibility of written or spoken material by measuring the strength of such factors as difficulty of vocabulary, complexity of words, personal references and length of sentences Prof and Mrs Vernon's experiments included assessments of these and other qualities up to a total of thirty-five different factors, which were thought by the investigators or by B B C talks producers to be important

Objective qualities in the scripts were measured by taking sample passages of 500 words and counting numbers of active verbs, concrete nouns, prepositions, references to numbers, etc Other qualities in the talks such as number of teaching points, concreteness, lucidity, good or poor delivery by the speaker, could only be assessed by having B B C talks producers and the investigators rate them independently, and taking their combined judgments

Most of the 4,600 listeners taking part in the investigation were soldiers in Home Commands who were listening as part of their normal educational activities An average of 92 subjects per broadcast, representing the full range of intelligence and education, completed the test papers The responses took the form of (*a*) five-point ratings recording easiness or difficulty of understanding the broadcast, (*b*) similar ratings of interest, and (*c*) attempts to reproduce in the listener's own words the main points of the talk

Listeners' reproductions were marked against a scale of up to six teaching points drawn up by the investigators A borderline of 3 marks out of 12 was taken as the point below which the listener evidently quite misunderstood or failed to make much sense of the talk Supplementary experiments showed that this was a fair and reliable method of testing comprehension, for although interviews with subjects, and 'prodding' with questions about particular points in a talk, produced rather more material than written recall, the relative scores of groups of listeners subjected to both methods remained much the same for different broadcasts

For the average broadcast—and the Forces broadcasts are among the simplest in the B B C 's output—the following proportions of the four intelligence and educational groups fell below the borderline of 3 marks, that is, were unable to grasp the gist of the talks

| % of population | Intelligence/Educational group | % below borderline |
|---|---|---|
| 10 | School certificate or above | 8 |
| 20 | Above average intelligence | 29 |
| 40 | Average elementary school | 56 |
| 30 | Backward | 82 |

The correlation between intelligibility scores and education plus intelligence level is very high, +0 62, showing the need to adapt the level of a talk to the level of the audience If one leaves out of account the backward, sub-literate 30 per cent of the population, for whom the educational talk is probably an unsuitable approach, roughly half the remaining samples understood even the more difficult series such as "Plain English", and the better "Current Affairs" and "Science" talks were comprehended by about three-quarters of these average and superior groups

Prof Vernon's analysis of the qualities making for intelligibility showed that by far the most important factor, apart from the intelligence and educational level of the listener, is the degree of interest in the content of the talk Between intelligibility scores and listeners' judgments of interest the correlation varies from 0 47 for the higher educational levels to 0 64 for the lower So strong is the interest factor that many of the talks on science and current affairs which bore all the marks of difficulty (for example, a large number of teaching points, many difficult words, complexity of style), but which dealt with an interesting topic, were actually comprehended better than other talks which had the simplest of constructions and were sometimes dramatized, but proved rather boring to their listeners

When the interest factor is held constant, the importance of some of the stylistic features emerges Factors reducing understanding are an excess of major points, overlong sentences, numerous difficult words, abstract nouns, prepositional clauses, metaphors and figures of speech, and over-rapid delivery Factors making for understanding are a lucid or lively style, a clear summary at the end of a talk, concreteness of treatment as well as of subject-matter and illustration of an abstract point so long as it is directly and obviously linked to the point Nevertheless, a talk is a whole which is more than the sum of all these parts and a competent speaker, dealing with an interesting subject, can make himself understood even if he breaks most of the rules of which Flesch and the American readability experts would approve

Mr Joseph Trenaman (assistant further education officer, B B C ) said he has been able to measure, on the basis of tests of only a few talks, as well as immediate recall, something of the wider effectiveness of broadcasts, for example, memory of content and changes in interest after a lapse of time, and application of the information given in a broadcast to new situations Listening has also been compared with reading as a mode of presentation, all the tests on two broadcasts being carried out with matched pairs of groups, one listening and the other reading the script of the broadcast. The samples, numbering 912 for the three programmes on science, were drawn from three educational levels—sixth forms of grammar schools, second-year technical students, and non-vocational students (ex-modern schools) released by their employers for further education.

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* Substance of papers read before Section J (Psychology) of the British Association at Birmingham on September 5 by Prof P E Vernon, Mrs D F Vernon and Mr J Trenaman

The responses were marked against a scoring key which was obtained by combining the assessments of a number of science teachers and education officials of the important points of the script. As many as 37 points were thus recorded, and marks of from 1 to 5 allotted according to the emphasis and agreement of the assessors. After the reproductions had been marked, samples of the several scores from 0 to more than 40 for each broadcast were arranged in random order and sent, without any marks attached, to five science teachers who were asked, after studying the original script, to sort them into those which showed at least sufficient understanding of one of the important points of the broadcast and those which did not. The results showed close agreement, and borderlines were fixed accordingly, from 15 to 30 per cent up the scale of marks. They were lowered slightly to allow for additional points brought out by listeners in applying the ideas of the broadcasts to new situations.

The most difficult of the three talks was one given by a distinguished physicist on electronics. It was intended for the general public, and the speaker had been at great pains to make it simple. It proved intelligible to about two-thirds of the grammar school listeners, but only to small minorities below that level, and could not have been understood by more than 10 per cent of the adult population. The second broadcast, a Forces educational talk on sources of energy, was understood by about half the sample population, with much the same distribution as that given in Prof. Vernon's table. The third broadcast, also on a source of energy, was a dramatized programme originally put out for fourteen-year-old 'modern school' children. This was comprehended by nearly two-thirds of the sample groups. Dramatized stories from this broadcast, in the same way as vivid images, were very frequently reproduced, and were more easily retained, as was shown in the reproduction of such items on delayed recall. But, as Prof. Vernon found, quite often the point which the story was intended to illustrate was lost in the process.

Listeners were asked to rate their interest in the broadcasts. The differences between ratings made immediately after listening and those made a week later were striking. On average they fell by as much as one-third of the normal range of such ratings. The loss was particularly great in the case of grammar school listeners, who heard the dramatized programme for secondary 'modern' children; many of them found it very interesting at the time but on retrospect they thought it childish or slow. Taking average scores for whole samples, it was found that the more interesting talk proved also to be the more widely understood. Yet within the audience to any one of the broadcasts an entirely different relationship appeared. At the three educational levels the two factors vary inversely; thus, grammar school listeners understood the broadcasts most widely but were least interested; 'modern school' types understood them least and were most interested. As between individual listeners, the regression of understanding on interest is curvilinear. Great enthusiasm usually accompanies imperfect understanding, and with less enthusiasm there is increasing understanding, until below the median the two factors diminish in equal ratio. So, although interest is the most powerful factor making for intelligibility, of which average interest ratings may be taken as a rough-and-ready index, the same correlation is found neither between individuals nor between educational levels.

Each of these three science broadcasts achieved its greatest effect at a different educational level. The talk by the physicist was most enjoyed at the grammar school level; the Forces educational talk at technical student level, and the schools programme at 'modern school' level. In each case the educational group which most enjoyed the broadcast found it just, but only just, within its grasp (that is, about two-thirds of the group obtained scores above the borderline). Since limits of understanding vary so widely throughout the population, and since what is found interesting by one educational level is not acceptable to others, it would seem to follow that scientific material must be communicated at several different levels of difficulty if it is to be generally intelligible.

The parallel tests of reading and listening to the three science broadcasts showed that it made no significant difference whether that material was communicated through the written or the spoken word; both were equally effective on immediate impact, after a lapse of time, and in application of the ideas to new situations.

J. Trenaman

# BIOCHEMICAL AND BIOLOGICAL EFFECTS OF DIETHANOLAMINE

## Glycogen and Lipid Content of the Liver of Mice receiving Simple Alkanolamines

THE intraperitoneal administration of diethanolamine over a period of time to white laboratory mice kept on a stock diet (percentage composition: corn flour 75; casein, 8; meat powder, 6; fat, 3; peanut oil, 6; cod liver oil, 1; and salt mixture, 0.3) led to an increase in the glycogen content of the liver and to a decrease in its total lipid content. The water content of the liver was also increased. At the same time the weight and size of the liver of the animals became enlarged.

The physiological action of monoethanolamine and triethanolamine seemed to be simpler and, within the limits of our experiments, led only to an increase in the water content and to a decrease in the total lipids of the liver of the mouse. The glycogen content seemed to be unaltered.

It is suggested that the biological reaction of diethanolamine is a complicated one, and that different cell constituents may be involved.

Eperjessy and Zathureczky[1] reported that in a Warburg experiment some aliphatic amines—especially alkanolamines—decrease the respiratory quotient of the surviving liver tissue of the rat. They concluded that alkanolamines speed up the metabolism of the lipids in the liver. Artom *et al.*[2] found in the liver of rats maintained on low protein diets that the administration of a single large dose of either diethanolamine or ethanolamine stimulated lipid phosphorylation

They also found a drop in the total lipids in the liver of rats maintained on similar diets for twelve days and supplemented with diethanolamine

As a rule, an injection period of three days gave the required effect The last injection was given at 9 a m on the day of the experiment Food was withheld, but water was given *ad libitum* After a starvation period of five hours, the animals were decapitated and their livers removed and weighed In each case the same parts of liver were used for the lipid and glycogen analysis

Liver glycogen was determined by the method of Hood and Kramer *et al* [3] For the quantitative determination of lipids in the liver we used the method of Bloor[4]

| No of expt | Substance | Days of treatment and amount of substance (mgm ) | Body weight (gm ) | Liver weight (mgm ) | % of water | % of sugar | % of lipid |
|---|---|---|---|---|---|---|---|
| 1 | Diethanolamine<br>Control | 2/6 | 28 4<br>31 4 | 1,314<br>1,141 | 70 5<br>69 0 | 1 2<br>0 4 | |
| 2 | Diethanolamine<br>Control | 2/12 | 25 2<br>26 3 | 1,445<br>1,158 | 66 4<br>65 5 | 1 5<br>0 4 | 22 4<br>24 4 |
| 3 | Diethanolamine<br>Control | 3/12 | 29 0<br>30 8 | 1,430<br>1,084 | 69 7<br>67 2 | 1 7<br>0 3 | |
| 4 | Diethanolamine<br>Control | 5/6 | 25 6<br>26 0 | 1,184<br>1,032 | 72 9<br>69 2 | 4 7<br>0 5 | 23 0<br>27 5 |
| 5 | Diethanolamine<br>Control | 30/12 | 29 2<br>30 3 | 1,551<br>1,138 | 72 5<br>69 8 | 2 2<br>0 9 | 20 7<br>23 8 |
| 6 | Diethanolamine<br>Control | 48/8 | 26 3<br>27 0 | 1,446<br>1,030 | 70 4<br>69 0 | 1 9<br>0 4 | 19 7<br>27 3 |

Diethanolamine was used in the form of its hydrochloride-salt Maximal quantities injected were 0 4 ml Body-weight means weight of dead animal without liver All values of sugar and lipids are related to the dry weight of the liver

The results are shown in the accompanying table

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[1] Annau, E , Eperjessy, A , Mihályi, E , and Zathureczky, Z , *Z phys Chem* , **282**, 69 (1947)

[2] Artom, C , Cornatzer, W E , and Crowder, M , *J Biol Chem* , **180**, 495 (1949)

[3] Hood, H A , Kramer, H , Somogyi and Mitchell, *J Biol Chem* , **100**, 458 (1933)

[4] Bloor, W R., "Biochemistry of the Fatty Acids" (1943)

## Alkaline Phosphatase Activity and Nuclear Changes in the Liver induced by Diethanolamine

THE experiments described in the previous communication showed that prolonged administration of diethanolamine to white laboratory mice produced an increase in the glycogen content of the liver and a decrease in the content of total lipids At the same time the weight and size of the liver of the test animals became enlarged

Artom *et al* [1] showed that the administration of diethanolamine in a single large dose leads to an increased phosphorylation of the lipids in the liver of rats As a consequence, it was suggested that the increased lipid metabolism, that is, phosphorylation, may be connected with phosphatase activity

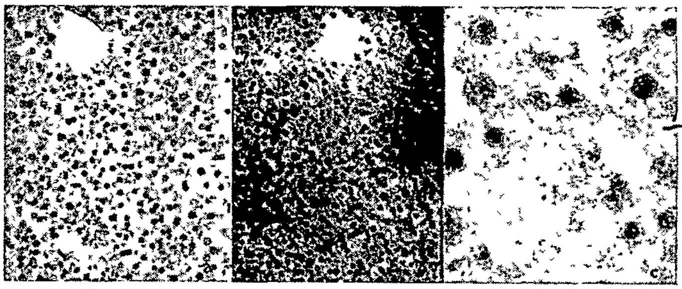
(× 200)
Control
(× 200)
(× 600)

Fig 1 Liver tissue after intraperitoneal injection of 12 4 mgm diethanolamine for 3 days

Chemical examinations showed that diethanolamine administration for at least three days induces a significant increase of the alkaline phosphatase of the mouse liver. Acid phosphatase seemed to be unaltered

For the quantitative evaluation of the phosphatase activity of the mouse liver we used the method of J P Greenstein[2], in which homogenized liver tissue is suspended in distilled water (1 10) and extracted for twenty-four hours in the cold Sodium-glycerophosphate (Merck) served as substrate Phosphorus was determined by the method of Fiske and Subba Row[3] (see table).

| No of expt | Substance (mgm ) | Days of treatment | Phosphorus (mgm ) | Phosphorus in controls (mgm ) |
|---|---|---|---|---|
| 1 | Diethanolamine, 12 4 | 3 | 0 0033 | 0 0014 |
| 2 | ,, | ,, | 0 0035 | 0 0008 |
| 3 | ,, | ,, | 0 0032 | 0 0016 |
| 4 | ,, | ,, | 0 0018 | 0 0012 |
| 5 | ,, | 6 | 0 0019 | 0 0008 |
| 6 | ,, | ,, | 0 0022 | 0 0011 |
| 7 | ,, | ,, | 0 0056 | 0 0014 |
| 8 | ,, | ,, | 0 0027 | 0 0014 |

Sodium-glycerophosphate (Merck) 2 per cent, 0 5 ml , veronal-buffer *p*H 8 8, 5 ml , enzyme solution, 1 ml ; distilled water, 2 5 ml Time of incubation, 1 hour

Histochemical phosphatase investigations by G Gomori's method showed also a well-defined increase in alkaline phosphatase in the liver tissue (Fig 1) The observations seem to suggest that diethanolamine induces increased production, at first in the nucleolus, of alkaline phosphatase, which eventually fills up the

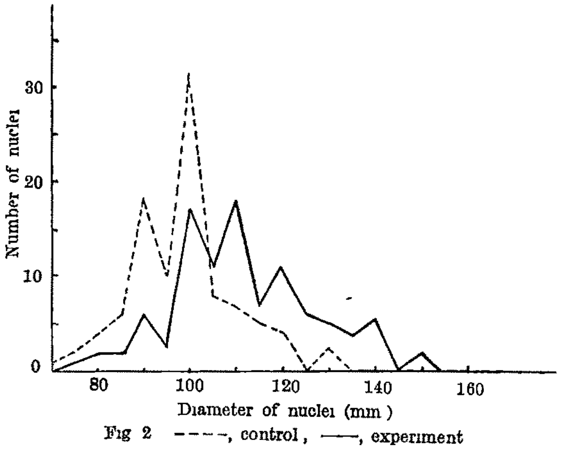

Fig 2 ----, control, ——, experiment

whole of the nucleus, whence it diffuses out into the cytoplasm

Measurements of the size of cell nuclei of mouse liver showed that diethanolamine administration increases their size, that is, the number of small and medium-sized nuclei diminish and large nuclei appear in a greater quantity (Fig 2) No mitoses could be detected in the cells of the enlarged livers

It is suggested that the action of diethanolamine on mouse liver may manifest itself to a large extent in a change of the phospholipid pattern of the cell nuclei This view is supported by the observations of Artom *et al*, who showed that by prolonged administration of diethanolamine, choline is partly replaced in the lecithins by diethanolamine, and by the work of H H Williams *et al*[4], who concluded from their experiments carried out on rat hepatoma, produced by feeding butter-yellow, that "the pathological derangement of the phospholipid content of the liver cell occurs primarily in the nucleus"

We are indebted to A Fajer for carrying out the analytical work

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A MANGINELLI

Fundação Andréa e Virginia Matarazzo,
Faculdade de Medicina,
Universidade de São Paulo May 11

[1] Artom, C, Cornatzer, W E, and Crowder, M, *J Biol Chem*, 180, 495 (1949)

[2] Greenstein, J P, *J Nat Cancer Inst*, 2, 551 (1942)

[3] Fiske and Subba Row, *J Biol Chem*, 66, 375 (1925)

[4] Williams, H H Kaucher, M, Richards A J, Moyer, E Z and Sharpless, G R J, *J Biol Chem*, 160, 227 (1945)

# APPLICATIONS OF ISOTOPES IN SCIENTIFIC RESEARCH

A CONFERENCE on the "Applications of Isotopes in Scientific Research" took place in the University of Melbourne during August 14–17 under the auspices of the Chemistry Department of the University and the Commonwealth Scientific and Industrial Research Organization The eighteen papers presented fell roughly into two main groups those of a general character dealing with methods of assay, health hazards and limitations of the use of isotopes, and papers that were essentially reports of work in progress

F K McTaggart and I E Newnham illustrated the use of zirconium-95 and hafnium-181 as tracers in the study of chemical methods of separating the elements zirconium and hafnium, and presented some new solubility data for the salts of these two metals Physico-chemical limitations of the tracer technique were considered by Dr G M Harris In a discussion of the exchange of carbonate ion (containing carbon-14) with carbonato-tetrammine cobaltic ion, it was pointed out that any attempt to describe quantitatively the kinetics of the reaction must take into account the isotope effect

Many instances of variations in the relative abundance of stable isotopes of the lighter elements have been observed In his paper on the assay of stable isotopes, Dr J D Morrison added to the list of such variations that of the carbon-12/carbon-13 ratio (from 88 to 93) in Australian natural graphites

By means of numerous radioautographs C R Millikan illustrated the use of manganese-54 to study the distribution of manganese in diseased and healthy plants Anisotropy of the rate of the self-diffusion of tin in tetragonal single crystals of high purity, disclosed by the use of tin-113 as tracer, was reported by Dr W Boas and P J Fensham In polycrystalline tin it was found that the rate of diffusion along grain boundaries is generally considerably higher than that of volume diffusion except when the boundary is that between crystals of similar orientations or between twins The effects of structural factors and solvent on the ability of internal cobalt (II) complexes to exchange with cobalt II ions were considered by B O West in a paper on "Exchange Reactions and Problems of Chemical Structure"

Illustrating entomological applications of radioactive tracers, Dr M F Day outlined experiments in which methionine containing radiosulphur was fed to clothes moth larvæ. A wide difference between the mechanism of sulphur metabolism in this insect and in some other species is indicated The results of investigations of the mechanism of reactions in liquid sulphur dioxide by the use of oxygen-18 were discussed by Dr I Lauder Difficulties encountered in the synthesis of isotopic molecules containing deuterium were fully illustrated in F. I Andersen's account of the preparation of monodeuterio methyl bromide

Other papers read at the conference were concerned with the fundamentals of nuclear physics (Dr. J. C Bower), statistics of radioactivity (E A Cornish), assay of radioisotopes (Dr T H Oddie), applications of nuclear emulsions (Dr. V. D Hopper), tracer method limitations in biology (Dr W P Rogers), health and safety precautions (D J Stevens), attempts to concentrate potassium-40 (Dr G A Elliott), assay of radioactive minerals (J Daly), and general problems in the synthesis of labelled molecules (A M Downes). It is hoped that the full report will be available at an early date

D P MELLOR

# NATURAL PRODUCTS OF THE BRITISH COLONIES

## TWO NEW JOURNALS

THE functions of the Imperial Institute, at Exhibition Road, London, S W 7, have recently been reorganised, and two of its former Departments—Mineral Resources, and Plant and Animal Products—have now become, respectively, the Mineral Resources Division of the Colonial Geological Survey, and the Colonial Products Advisory Bureau Previously, the work of these two Departments was published in the *Bulletin of the Imperial Institute*, the *Bulletin* is now replaced by two separate quarterly journals *Colonial Plant and Animal Products*[1], and *Colonial Geology and Mineral Resources*[2]

The issue of the first number of the former periodical is of particular significance at the present time when the public conscience has awakened to the pressing needs of the Colonies As the former Secretary of State for the Colonies, Mr A Creech Jones, states in a foreword, the resources of the dependent territories are of increasing importance both to the inhabitants themselves, who demand a higher standard of living, and to the whole of the sterling area Much was done in the years between the two World Wars and also, let it not be forgotten, in the period before the First World War, to assess the economic potentialities of these territories But during that time the workers were all too few, and with the best will in the world they could touch only the fringe of the work. As is well known, the aftermath of the Second World War has led to profound changes, not only territorially but also financially, due to difficulties that have arisen through currency restrictions. Inevitably attention in Great Britain has been directed to the vast and largely unassessed potentialities of the Colonies, which, being within the sterling area, afford wonderful opportunities for mutual trade to the benefit of both the mother country and the dependencies.

Previously much of this work was carried on by the Imperial Institute and other bodies working independently, and the former *Bulletin* of the Institute was regarded by most scientific workers in the tropics as a valuable work of reference on natural products. As regards the agricultural research work done at the Imperial Institute laboratories, this was valuable to investigators in the tropics, as it helped them to assess the commercial possibilities of products arising from little-known plants. With the assistance so provided, the worker in the Colonies was able to guide his further researches, if the prospects seemed good, for the development of a profitable market, or to turn his attention to more profitable lines of work if the reports should be unfavourable. A reference to files of agricultural departmental reports will provide numerous examples of the work done in this connexion. The assessment of new types of oil from little-known plants is one example; another is the evaluation of different kinds of fibre obtained from plants that were not hitherto considered to have commercial potentialities; and a third concerns plants of medicinal value. For example, the establishment of the tung oil industry in countries such as Nyasaland, and the development of jute fibre substitutes such as ramie and hibiscus owe much to the pioneer work of the Institute.

Now, with the pressing needs of the times, all this work has, of necessity, been brought under the central direction of the Colonial Products Advisory Bureau, and *Colonial Plant and Animal Products* indicates that the continuity of these investigations is assured under the new organisation. The first issue reports, for example, on two little-known oil seeds, namely, *Lippia carviodora* from Kenya, and *Hibiscus esculentis*, which was always regarded hitherto as a somewhat uninspiring vegetable. Reports on manila hemp in Borneo, and the suitability of banana trash for paper-making, carry on the traditions of the old Fibre Section, and a note on wormseed (*Santonica*) continues the pharmaceutical tradition. There are three original articles: sugar cane processing; the insect fauna of *Lonchocarpus* and derris (for, curiously enough, these insecticidal plants are themselves subject to attack by various beetles when their dried roots are in storage); and a note on the preparation of silk gut.

Finally, one is glad to see that the bibliography for agricultural and forestry subjects is continued, as it adds greatly to the value of the journal. Under its new form it is believed that this publication will help to stimulate still further the interest of all interested in Colonial development.

The purpose of the other new journal, *Colonial Geology and Mineral Resources*, is to record the progress that is being made in the geological investigation of the various territories comprising the Colonial Empire and to provide information of current developments in mineral resources, mining and mineral economics. The first number appropriately contains an authoritative account, by Dr. F. Dixey, of the scope and work of the Directorate of the Colonial Geological Surveys. The primary purpose of the Surveys is the preparation of a basic geological map of the Colonial Empire to serve as the foundation for a thorough investigation of mineral resources. Since the time when the Directorate was established in January 1947, many of the old Surveys have been expanded and plans for new ones have been approved, the territories in which work is now actively in progress being Uganda, Kenya, Tanganyika, Northern Rhodesia, Nyasaland, Bechuanaland, Swaziland, Nigeria, Gold Coast, Sierra Leone, Malaya, Sarawak and North Borneo, Fiji, British Guiana, Jamaica and Cyprus. The overseas and London staffs numbered 111 and 25, respectively, in April 1950 and are expected to reach 160 and 45 by the end of next year.

The journal provides "a convenient forum for the expression of responsible geological thought and opinion" and its contributors are not to be limited to members of staff. The present issue, for example, contains a most valuable article by H. R. Hose, of Aluminium Laboratories, Ltd., on "The Geology and Mineral Resources of Jamaica", accompanied by specially prepared geological and mineral maps. A permanent feature of the journal is to be a series of reports of recent progress, contributed by the Surveys themselves. The first batch of eight clearly indicates that for this feature alone the new journal will be widely welcomed. Other sections are devoted to notes on special activities and conferences, discoveries of significance and abstracts of publications; book reviews; bibliography; personalia; and mineral and metal prices.

The Directorate and the editor, Mr. E. H. Beard (vice-principal of the Mineral Resources Division), are to be congratulated on their enterprise in producing an attractive, authoritative and inexpensive journal which adequately meets a real need and which, apart from its wide appeal to mining engineers, economists and industrialists, will undoubtedly be highly appreciated by geologists, not only in Great Britain and the British Colonies but also throughout the world.

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[1] *Colonial Plant and Animal Products*, 1, No. 1 (1950). (London: H.M. Stationery Office.) 5*s*. net.

[2] *Colonial Geology and Mineral Resources*: The Quarterly Bulletin of the Colonial Geological Surveys, 1, No. 1 (1950). Pp. 120. (London: H.M. Stationery Office.) 5*s*. net.

# THE IMPERIAL FORESTRY INSTITUTE, OXFORD

ON October 19, H.R.H. Princess Margaret, in the presence of a large and distinguished gathering, opened the new building of the Department of Forestry of the University of Oxford, on a site in South Parks Road between the Physical Chemistry and Pathology Departments. The Imperial Forestry Institute was founded in 1924 as the outcome of recommendations of the Empire Forestry Conferences of 1920 and 1923, to provide an Empire centre for higher education and research, to be jointly financed by the governments interested and linked with the already existing University School of Forestry. The School owed its origin to arrangements made in 1905 between the University of Oxford and the India Office for the training of probationers for the Indian

Forest Service at Oxford after the Royal Indian Engineering College at Coopers Hill (near Windsor) had closed down. From the start, the need for an adequate building for the new venture was recognized, but, at the time, the necessary money could not be found. Temporary accommodation was secured where it could be obtained, and the staff now accommodated under one roof has been gathered in from four buildings in as many streets. The fine new four-storied building in Bladon and Clipsham stone has been constructed with funds from various sources, beginning with generous gifts from the Rajah of Sarawak, the Rhodes Trust and the Pilgrim Trust; a large contribution was made from the Colonial Development and Welfare Fund, and the University has borne the large increase in building costs since the plan and estimates were approved in 1945.

The new Institute accommodates the old School and Institute, which are now combined to form the Department of Forestry (the 'Imperial Forestry Institute' is the statutory designation of the building in which it works), and also the Commonwealth Forestry Bureau, an organization that is entirely independent financially and administratively but otherwise dependent on the Library of the Institute for its functioning as the central information service on forestry for the Commonwealth. The teaching activities continue to cover both undergraduate and postgraduate courses as well as training in research. All probationary officers of the Colonial Forest Service take a postgraduate course after a tour of duty in the Colonies, and under a special arrangement with the Governments of India and Pakistan some of the junior officers of their forest services go to the Institute for a similar course planned to meet their special requirements. There are usually some forest service officers on study leave and other foresters undertaking special studies or actual research work from the Colonies and Dominions and occasionally from foreign countries.

Practically every timber-producing part of the Commonwealth has contributed timber to the building, a suggestion that such gifts would be welcome having met with a most generous response from governments and timber-trade organizations. Eleven of the rooms have been panelled with different timbers thus received, and fourteen kinds of timber have been used for flooring blocks. The furniture has been constructed from nearly thirty different woods, and more than a dozen have been used for general furnishing for shelving, bench tops, cupboards, seating, etc. The doors form an exceptionally fine display of home-grown and imported timbers, twenty-four species being represented, all of them available on the open market. It will be apparent that the building has many unique features, and as one speaker described it, "it is worthy of forestry and worthy of Oxford".

In all, the School has nearly a hundred rooms, including three lecture rooms, three teaching laboratories and three other rooms suitable for small classes so that four courses can be run simultaneously when required. The main sections provide for work on sylviculture, pathology, wood structure, engineering, economics, systematic botany, entomology, mensuration, management, physiology, ecology and microbiology. There are also seven small research rooms.

The Library, with connected activities, occupies the whole of the front of the first floor. It claims to be the most complete of its kind, aiming at world cover in forestry proper. It contains about 4,500 bound books and some 25,000 pamphlets, etc., while the periodicals comprise more than three hundred series in twenty-one languages, and the collection of forest administration reports is nowhere paralleled. The Forestry Bureau occupies rooms immediately adjoining the Library and deals with all literature received directly it has been registered; it provides the reference slips for the card indexes which now contain about 200,000 cards and are growing at the rate of 16,000 yearly.

Common services include well-equipped workshops for both wood- and metal-work, photographic and artists' sections, two balance rooms, a computing room, and a low-temperature room. The photographic collection contains about 8,000 prints and 3,000 lantern slides.

The Forest Herbarium of the old Institute has been transferred to the Department of Botany and will be housed in its new building, which is now approaching completion and will be linked with the Forestry Department by a common lecture theatre. The wood collection includes about 17,000 specimens and a very large number of microscopic slides, British Colonial species being most strongly represented.

The opening ceremony began in the Milner Hall of Rhodes House, close to the new building, with an address of welcome by Prof. H. G. Champion and a speech by Princess Margaret, in the course of which she referred to the importance and efficacy of afforestation in checking soil erosion, as she had herself seen in South Africa, and to the record of achievement of forestry in India. She also pointed out that "the responsibilities of the forester do not stop at the scientific and commercial aspects of timber production. It falls to him to make our woods and forests as lovely as possible so that we may all enjoy them. . . . This calls for a close understanding between forester, farmer, sportsman and, indeed, all those who love the country". In a few felicitous phrases, the Vice-Chancellor thanked Princess Margaret, suggesting that the most satisfying experience life can afford is for one's work to have to do with things that are both beautiful and useful, as are trees.

The Royal party then walked in procession to the Institute, where the Princess planted a yew tree, chosen as an appropriate symbol of longevity and durability, and she formally unlocked the doors. She was conducted through the chief rooms and saw an exhibition staged to demonstrate the ways in which forests and forestry contribute to general welfare, and to illustrate the various fields in which research is in progress. On leaving, she spoke to the workmen who had been engaged in the building work, some of them for the whole five years it has been in progress. The three hundred guests, who included representatives of the governments and forest departments of most of the Dominions and Colonies as well as several foreign countries, afterwards saw the main exhibition and also the ten sectional exhibits of a more specialized character. On the following day, about 250 persons connected with the University visited the new Institute, and on the third day about 450 of the general public.

The University of Oxford at last has a worthy building for its forestry work, and the contributing countries of the Commonwealth a well-equipped centre for advanced study. The only cloud on the horizon is a measure of insecurity as regards future financial provision for the maintenance of its activities.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications*

## Is Parthenogenesis Sexual or Asexual Reproduction?

CYTOLOGISTS and others commonly refer to parthenogenesis as asexual reproduction This usage is, for example, to be found in the books of Wilson[1], Darlington[2], and White[3], along with the facts that indicate that parthenogenesis is a derivative of normal sexual reproduction To an elementary student of these phenomena, parthenogenesis appears to have much more in common with other types of sexual reproduction, and to refer it to asexual reproduction puts it in the same general category as budding and fission, to which parthenogenesis has little or no significant resemblance The fact that parthenogenetic eggs develop without fertilization is no doubt responsible for this usage, a fact which, however, need not carry the entire weight of the decision as between sexual and asexual reproduction True enough the biological significance of sexual reproduction is in part dependent upon fertilization , but most of this significance also relates to cross-fertilization, which is by no means co-extensive with sexual reproduction

Sexual reproduction should not be diagnosed entirely upon the basis of what happens to an egg *after* it is formed There has been a long biological history behind the development and perfection of mechanisms and processes which have made it possible to produce any kind of egg at all In fact, an egg is a gamete, produced most commonly in a specialized female gonad During its production complex gametogenetic processes of great significance normally take place, though some of these may be secondarily reduced in such a way as to secure the advantage of the normal efficiency of sexual reproduction without requiring the union with a sperm for activation Whether parthenogenetic eggs are produced meiotically or ameiotically, there is usually evidence that such production is a derivative of the usual gametogenetic processes, and few, if any, cytologists now deny that parthenogenesis is a derivative of normal sexual reproduction

If these things are true, there is no such thing as an 'asexual egg' An egg is always a gamete, usually formed in a definite ovary, and, whether this ovary belongs to a female or a hermaphroditic organism, it is associated with femaleness and, of course, sex Commonly, also, it is stored temporarily and then conducted from the body in accessory female reproductive organs So far, certainly, there is nothing in common with asexual methods of reproduction other than the fact that a step which may lead to the production of a new individual has been taken

Let us consider an informative example such as the occurrence of haploid parthenogenesis in the honey bee All eggs are reduced and haploid, having undergone typical gametogenesis Such eggs are produced normally only in the ovaries of the queen Assuming the marriage flight has occurred, most of these eggs will be fertilized and produce females, mostly workers But some of these eggs may remain unfertilized and develop into drones or males Whether any particular egg shall be fertilized or not depends upon the physiological operation of the female machinery which allows sperm access to the eggs or denies it Thus the sex of the offspring is determined To recapitulate *female* gametes, produced in *female* gonads, and stored in *female* accessory organs are either fertilized or not, depending upon the operation of the *female* reproductive machinery, which has been supplied previously with *male* gametes If the eggs are fertilized they become *females*, if they remain unfertilized they become *males* There is not an asexual atom in this whole procedure !

If this may be considered an extreme case, it nevertheless differs from other parthenogenetic cycles only in degree As Wilson[1] quotes Brachet with approval, there is "a veritable bridge set up by Nature between fertilization and natural parthenogenesis" There may be transition also between normal sexual reproduction and asexual reproduction, but such transitions do not follow the route of parthenogenesis Sexual reproduction is better characterized as reproduction which involves gamete formation, and thus is distinguished from asexual reproduction which does not involve gamete formation To continue to describe parthenogenesis as asexual can only lead to confusion as we attempt to understand the evolution of specialized sexual reproductive processes from the more primitive asexual mechanisms which involve mainly budding and fission Proper usage of the terms already available should make it possible for us to express ourselves clearly and effectively in discussing this general topic along the lines indicated However, if there are good and sufficient reasons for continuing to refer to parthenogenesis as an asexual process in spite of the foregoing statements, then we should all benefit by having them clearly set forth.

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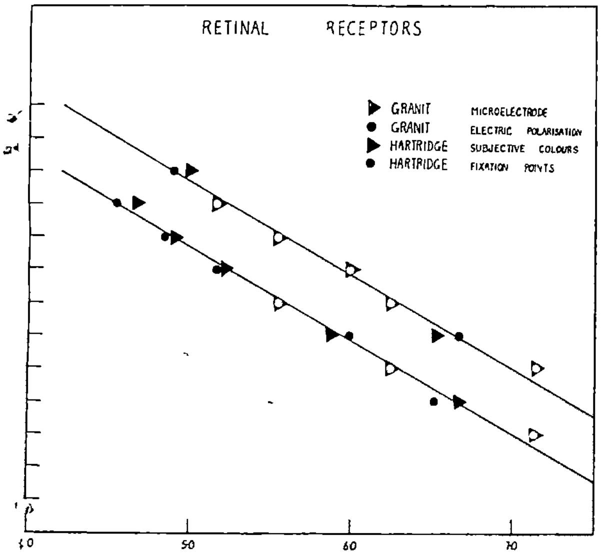
[1] Wilson, E B , "The Cell in Development and Heredity", 3rd edit (Macmillan, New York, 1925)

[2] Darlington, C D , "The Evolution of Genetic Systems" (Cambridge University Press, 1939)

[3] White, M J D , "Animal Cytology and Evolution" (Cambridge University Press, 1945)

## The Retinal Receptors

DARTNALL'S discovery, reported in *Nature* of August 5, p 207, of two new retinal pigments, visual yellow 2 and visual red, together with the fundamental observation that the crests of the known pigments are separated by equal frequency intervals, leads to the expectation of the discovery of further pigments Since those already known are iodopsin (visual blue) (0 57 μ), visual violet (0 533 μ), visual purple (0 502 μ), visual red (0 475 μ) and visual yellow 2 (0 407 μ), the additional ones in the visible spectrum should be visual green (0 655 μ), visual blue-green (0 609 μ), visual orange (0 450 μ) and visual yellow 1 (0 427 μ) Dartnall's discovery also raises an important issue, namely, are the results of these physico-chemical investigations in agreement with the physiological ones which have been performed by other workers, both on man and on certain animals ? If agreement is found, the reliability of both types of investigation is greatly increased. In the accompanying table are shown (*a*) the wavelengths of the crests which would be expected on a quantum theory basis , (*b*) those found by Granit in animals' eyes by means of the micro-electrode method , (*c*) those found by Granit in animals' eyes using the electric polarization method , (*d*) those



Upper graph, Granit's animal receptors, lower graph, writer's human receptors, both drawn on Dartnall's equal frequency interval lines Where triangles and dots coincide the latter are shown as white dots Equal frequency steps, vertical Frequencies, horizontal

found by me in the human eye by means of the fixation-point method, (*e*) those found by me in the human eye by means of the subjective colour method

| Quantum theory basis | Granit micro-electrode | Granit electric polarization | Hartridge fixation points | Hartridge subjective colours |
|---|---|---|---|---|
| 655 | — | — | 660 | 640 |
| 609 | 600 | 610 | 620 | 610 |
| 570 | 580 | — | 580 | 575 |
| 533 | 540 | 520 | 540 | 540 |
| 502 | 500 | — | 500 | 510 |
| 475 | 480 | — | — | 480 |
| 450 | 460 | 450 | 460 | 450 |
| 427 | 420 | — | 420 | 420 |

These results are plotted in the chart The two full lines correspond to Dartnall's equal frequency interval relationship The plotted points in the upper graph show Granit's results, by circles with the micro-electrode method and by triangles with electric polarization method The plotted points in the lower graph show my results, by circles with the fixation point method, and by triangles with the subjective colour method

It will be observed that there is good agreement in both cases between the theoretical curve and the experimental points both for man and for animals It will be remembered that Dartnall has also found good agreement between the theoretical curve and the pigments which have been so far found in the retina of the tench Putting these facts together, it follows that men and certain animals have receptors in their retina, the response curves of which have crests very close in spectral position to those to be expected if the retinal pigments act as photocatalysts for those receptors This conclusion is important, because until now it has been a matter for conjecture whether the photopic receptors, the cones, have a similar or a different mechanism from that of the scotopic receptors, the rods It now appears certain that the mechanisms are closely similar, visual purple acting as a photocatalyst for the rods, and a number of different, but chemically related, pigments acting as photocatalyst for the cones

But there is another point to be considered In order that the photopic pigments may form a series, the members of which differ from one another by equal frequency intervals, it follows that they must be chemically related, differing from one another, however, by the substitution of one chemical group for another To take a very simple example, one pigment might have one hydroxyl group somewhere in its molecule, the next pigment in the series might have two such hydroxyl groups, the third might have three, and so on Such a scheme would provide a series of related pigments with an equal frequency interval between them

Now if one of these pigments could be identified, it should not be difficult to ascertain the identity of one of the others, and thus to ascertain the chemical relationship between them This should lead to the recognition of the chemical structure of them all

Evidence is to be presented elsewhere for the hypothesis that the yellow pigment with a crest at 0 475 $\mu$, that is, the photocatalyst for vision in the blue part of the spectrum, is a carotinoid, related to xanthophyll, $C_{40}H_{56}O_2$ If this be true, the relationship between this visual pigment and vitamin A is established It will be recollected in this connexion that visual purple is itself a derivative of vitamin A

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## Genetical Reduction of a Reproductive Unit in Relation to the Male-Female Ratio

In two previous papers[1,2], I have referred to artificial insemination from the genetical point of view and arrived at the conclusion that the genetical reduction it produces is its main disadvantage Recently, Sir John Russell in a lecture on "World Population and World Food Supplies"[3] gave hopes of a better future Referring to artificial insemination he said "We may yet live to see bulls, other than a small select aristocracy, become unwanted anachronisms" My own opinion is that even in cattle democracy is a fundamental necessity, therefore I fully share Sir John's "lurking suspicion that Nature may resent being unceremoniously bundled out in this way", as he states a few lines after his rather sweeping statement. Nature would resent the genetical reduction produced by the increase of females in the ratio of 1 male to *n* females

In species with diploid genetical composition, a complete haploid set of chromosomes is inherited from the father and another set from the mother. In a reproductive unit—1 male to *n* females—50 per cent of the total number of chromosomes of the offspring come from the father independently of the number *n* of females Assuming that any animal has the capacity of carrying the same number of genes as any other of the same species, the total number of chromosomes inherited by the offspring of a reproductive unit decreases as *n* increases in the ratio of 1 male to *n* females

For example, if a group of 100 females is divided into five reproductive units with one male each, the total amount of haploid sets inherited by the offspring is 210 If the group is provided with only one male, 202 sets are inherited In a monogamous population 100 females form 100 reproductive units, and the maximum number of haploid sets, that is, 400, is available In the first case, the reduction is measured by the ratio 210/400 and in the second by 202/400 The reduction is 1 9 1 and 1 98 1 respectively If this happens again for a second generation, the reduction is greater, since 100 females are not carriers of 200 different sets of chromosomes but only 105 and 101 respectively If the former is divided again into five reproductive units with a male each, 115 sets of chromosomes will be available for the offspring, but the second unit with one male will be able to transmit only 103 sets of chromosomes. The measure of reduction is given by the ratio 115/400 in the first case and 103/400 in the second The reduction in the third generation will be 67 5/400 and 53 5/400, and so on in further generations The formula for the reduction is

$$\frac{(2^x - 1 + n_1)n_2}{(2^x - 1 + n_2)n_1},$$

where $x$ is the number of generations in which a given number of females has had only one sire and $n_1$ and $n_2$ the number of females of the units compared This formula measures the genetical reduction produced by artificial insemination compared either with a monogamous population where one male corresponds to one female, or with a population with any number of females per reproductive unit

If artificial insemination is used during ten generations in a group of 2,000 females the reduction, compared with a monogamous population, will be 3,023/2,048,000, which is equal to 0 00148 With the ratio 1 male/20 females, the reduction will be 1,043/20,480, which is equal to 0 051

For example, from the genetical point of view, a population of 100,000 females inseminated with only fifty males each generation during ten generations is able to transmit the same number of genes as another made up of 148 females with a male each, provided there is no inbreeding in both cases If the group was inseminated by 5,000 males each generation, also during ten generations, the number of genes would be that of a group of 5,100 females of a monogamous population without inbreeding This means that as the number of generations increases the reproductive units tend to carry the same number of genes independently of the number of females This point is almost reached after ten generations for groups of 1 male/20 females and after twenty generations for units of 1 male/2,000 females

From a genetical point of view, by means of artificial insemination a numerous herd is converted into the equivalent of one of small number, and as the only source of variability is the existence of different individuals, it will be fixed in its present state of evolution This is a serious handicap for the improvement of its qualities or adaptation to future needs Artificial insemination should be used, therefore, only during a few generations, when a breed is in a stage of either quantitative or qualitative diffusion

I wish to thank Prof R A Fisher for reading this communication and Dr J T Lewis for his interest and criticism

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[2] Rabasa, S L, *Ciencia e Invest*, **6**, 204 (1950)

[3] Russell, E J, *Nature*, **164**, 379 (1949)

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## Sexual Season of the Ewe and Daylight Environment

An exact knowledge of the duration of the breeding season of improved breeds of sheep in relation to daylight changes has an important bearing on the export of such breeds overseas, determining the areas in which different breeds can be used. Transferring sheep from one latitude to another even within the same hemisphere has been shown to have an effect on the ovarian rhythm through the change of light environment[1,2] J Hammond, jun [3] states that the breeding season of Suffolks is evenly spaced around the shortest day over a period when the length of daylight is 11½ hours or less J Hammond, sen [4], relates breed differences in the duration of the breeding season to the geographical origin of breed Yeates[5] reports that the onset and end of the breeding season occurs 10–14 weeks after the seasonal daylight curve changes over to shorter or longer daylight hours, respectively

A study of the natural breeding season of the non-pregnant ewe was started in October 1948, the materials being six British pure breeds, some of which had been maintained locally in Cambridge and some were purchased from flock breeders elsewhere The breeds investigated can be classified into three groups

(1) Breeds with a very restricted breeding season Blackface Mountain, Border Leicester and Welsh Mountain, which had a breeding season of 19 weeks average duration, and an average number of 7 cycles per ewe They bred when the length of daylight was 11½–12½ hr or less These breeds originated in the Scottish Highlands, Scotland and the Welsh mountains respectively, the first and last at high altitudes (about 2,000 ft above sea-level)

(2) Breeds of medium-length breeding season Romney Marsh and Suffolk, which had a breeding season of 26 weeks average duration and the ewes experienced on an average 10 cycles They bred when the length of daylight was 12–13½ hr. or less These breeds originated in the southern counties of England

(3) Breed with a prolonged season the Dorset Horn, which had a breeding season of 32 weeks average duration with 13 cycles It bred when the hours of daylight were 12–17 or less This breed probably originated partly from Merinos introduced from Spain

Thus there is a relationship between the duration of the breeding season and the latitude and altitude of origin of the breed

The differences in the extension of the breeding season were mostly due to different dates of onset The centre date of the season coincided with the shortest day in most breeds, whereas in the Dorset Horn it occurred seven weeks before December 21 There was no correlation between the dates of onset or end of the breeding season, on one hand, and the dates of change-over of the daylight curve, on the other hand In group (1) breeds, the ewes came on heat 17 weeks after the longest day and went off 9 weeks after the shortest day, whereas in the Dorset Horn they came on and off 4 and 10 weeks respectively from the change-over of the daylight curve

The ovarian activity of ewe lambs lasted approximately only one-fourth to one-third of that of adults of the same breed, as judged by the duration of the breeding season and by the number of œstrous periods The centre date for ewe lambs always occurred just after the shortest day, and they experienced their first heat just prior to the shortest day

Silent heat occurred with different frequencies in the breed groups, with a range of 0 25–1 40 silent heats per adult ewe per breeding season The average of silent heats expressed as a percentage of total cycles detected was 7 (62 per cent of those occurring after the shortest day)

Post-partum heat was experienced in 56 per cent of lactating Suffolk ewes, when the length of daylight (January–March) was 10–12 hr, and the length of the lactation anœstrus ranged from 1 to 9 weeks The post-partum conception-rate was 50 per cent, and it depended on suckling conditions

This work is being carried out in the Animal Research Station, Cambridge, while on study leave from the Fouad I University of Egypt It is still in progress, and detailed results will be published elsewhere I am indebted to Dr John Hammond for his continuous advice and encouragement

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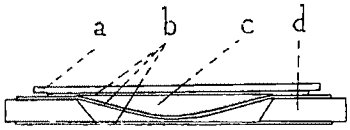
## Experimental Rearing of the British Harvest Mite to the Adult Stage

The periodical revivals of attempts at rearing harvest mites during the past half-century have led to few successes, and *Trombicula autumnalis*, the British harvest mite, has evaded the efforts of Hirst[1], André[2], Keay[3], and others to rear it further than the nymphal stage In view of the permanent hypogean existence of the nymphs and adults at some considerable depth below the surface of the soil (Cockings)[4], it is not surprising that difficulties have been encountered in trying to discover the food and environmental requirements of the post-larval stages

Miyajima and Okumura[5] first gained success in rearing *T akamushi* from the larva to the adult, but their account omitted much needful detail The American workers Melvin[6], Michener[7] and Jenkins[8] successfully maintained colonies of *Eutrombicula batatas* in 1946, mainly for the purpose of testing acaricides on the mites The rearing methods adopted, whether successful or otherwise, depended primarily on culturing the mites either in a layer of some suitable medium, like moist sterile soil, or in moist cotton wool, and mosquito eggs were recommended as the best food for rearing the nymphs and adults The methods employed by previous workers were unsuitable for following closely the progressive change of form of individual mites through the phases of their peculiar and complex post-embryonic growth-cycle Since my aim in rearing this mite was primarily to include its peculiar type of development in a study on growth in the Acarina, a convenient method had to be devised In 1949, after many attempts during previous years, the following method turned out to be successful

The larvæ, collected from the field, were nourished on young mice These were kept individually inside inverted glass funnels resting upon a wire gauze over Petri dishes, so that the engorged larvæ were trapped as they fell off the host The engorged larvæ were transferred to special filter-paper cells each cell consisted of a 'Perspex' framework (with 4-cm sides, 0 3 cm thick, and with a central aperture) which supported two squares of filter paper of appropriate size, one of which was depressed into the aperture so that the space between the two filter papers formed the chamber for housing the engorged larvæ and later stages (see diagram) The nymphs fed best on a mixture of moist chicken fæces, agar, yeast and molasses, the three last being constituents of a food used for culturing *Drosophila* The nymphs showed no desire to feed on the eggs of *Aedes ægypti*, and both young and old nymphs seemed incapable of piercing the outer membranes even after the eggs were moistened The fully engorged nymphs imbibe water and increase in bulk considerably before elongating and exhibiting the pupa-like features of the pre-adult transition stage, which closely resembles that preceding the emergence of the active nymph The mortality-rate of fed nymphs was very high, but six adults of various sizes were obtained, the pre-adult developmental phase lasted about thirty-six days at room temperature, 100 per cent relative humidity and about twenty-eight days at 25° C , 100 per cent relative humidity Attempts to force egg-laying at high temperatures failed



The filter-paper cell *a*, glass cover , *b*, filter papers , *c*, rearing chamber , *d*, 'Perspex' frame

So far as I am aware, this is the first time that *T autumnalis* has been reared experimentally from the larva to the adult stage Details of the method are included in a completed paper on the growth and development of this mite, which I hope to publish elsewhere

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## An Inhibitor of Salt Absorption in Root Tissue of Red Beet

De Kock and Hunter reported in *Nature* of September 9, p 440, the extraction from the seeds of sugar beet of a water-soluble oil which inhibited the respiration of root tissues and the germination of seeds

Recent experiments in this Department have indicated the presence in red beetroot during winter storage of a water-soluble substance which inhibits the ability of beetroot cells to absorb inorganic salts from solutions This was shown by the temporary cessation of salt absorption when a concentrated water-extract of beetroot was added to a solution from which disks of tissue were absorbing manganese chloride The addition to such solutions of the residues from chloroform extractions of ground-up beet tissue had no effect, however The active substance has not yet been separated from the water-extract.

The presence of an inhibiting substance in beetroot during storage accounts for the delay in the commencement of both cation and anion absorption from solutions for about fifty hours after cutting the intact roots The delay can be shortened by washing the cut tissue and so removing the inhibitor It must be assumed that the substance will also disappear from tissue by a natural process, probably of a respiratory nature, since when disks are kept in a limited volume of solution they eventually begin to absorb salts The inhibiting substance is thought to be concerned with the natural dormancy of beetroot during the winter, because extracts of young freshly pulled roots and old stored roots in the early summer do not inhibit salt absorption

The results will be reported fully elsewhere

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## Incidence of Salmonellæ in Fæces of Dogs suffering from Distemper

Cruickshank and Williams Smith[1] found five of five hundred healthy dogs (1 per cent) in London to be excreting salmonellæ in their fæces The technical methods used in this investigation consisted, briefly, in plating the samples directly on to Leifson's agar, and also after preliminary enrichment in selenite *F* medium and in tetrathionate broth Wolff, Henderson and McCallum[2] examined fæcal specimens from a hundred city dogs in Michigan by preliminary incubation in tetrathionate broth followed by plating on *S S* agar They found 18 (18 per cent) to be positive for salmonellæ Most of the positive samples were obtained from dogs suffering from distemper or from dogs maintained in a kennel where outbreaks of distemper and enteritis had occurred in the six months previous to sampling Kintner[3], simply by direct plating on *S S* agar, found 13 of 71 dogs (18 per cent) brought to the Ohio State Veterinary Clinic for treatment to be excreting salmonellæ in their fæces Of the dogs in this investigation, 50 per cent of those suffering from distemper were positive for salmonellæ, as were 10 per cent of the non-distemper cases

In view of the marked difference between the American and British figures, it was decided to investigate the problem further. With the help of a number of veterinary surgeons practising in the London area, rectal swabs were examined from a hundred dogs suffering from distemper or para-distemper (hard pad disease) The methods employed were those used by Cruickshank and Williams Smith[1] Only one of the samples (1 per cent) was found to contain salmonellæ This organism, *Salm typhimurium*, was isolated after preliminary enrichment in selenite *F* medium

These results suggest that there is little or no difference between the incidence of salmonellæ in the fæces of normal and distemper-infected dogs in London, and that distemper alone does not account for the incidence of salmonellæ in the fæces of dogs in American cities being so much higher than those in London. Kintner[3] considers that the high incidence in American dogs may be related to the diet, and quotes references to show the very high percentage of dog foods which may contain salmonellæ Wolff *et al* [2] also noted that some of the dogs examined by them were fed on reject eggs, and that the salmonellæ isolated from many of those dogs were of the 'dried-egg' variety It is possible, therefore, that the difference between the American and British figures may be accounted for by a difference in diet

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## Planck's Constant and the Fine-Structure Constant

ADVANCES in fundamental theory have often been guided by the principle that reliance is to be placed on the most directly observed quantities, that is, those involving least theoretical assumptions This letter indicates the interpretations of Planck's constant ($h$) and of the fine-structure constant ($\alpha$) which follow from this principle[1]

Of the measurements on which quantum theory is based, the most direct are lengths (wave-lengths, path curvatures). As is well known, the three classical theories of gravitation, electron dynamics, and the electromagnetic field are each scale-free, there being no constant of the dimensions of a length in their laws, taken separately But the quantum theory of discrete eigenstates is scale-fixed, $h$ providing in combination with other constants (for example, in the combinations $h/mc$, $h^2/4\pi^2me^2$, and $h^3c/2\pi me^4$, where $m$ equals electron mass) the basic standards of linear scale required to represent these states Apart from heat effects, which involve less direct measurements and more assumptions, $h$ is always calculated from characteristic lengths or from ratios of lengths Thus the above principle suggests that from the point of view of a future theory the characteristic feature of the phenomena involving $h$ is their definiteness of scale, rather than the 'quantization' of action or energy (Lengths of the order $e^2/mc^2$ are less reliable than the above lengths involving $h$, for they are less directly measured and rest on a high extrapolation of the inverse square law from larger-scale observations )

The most direct measurements yielding $\alpha$ involve ratios of the above three lengths (ratios of characteristic wave-lengths, and of these to atomic radii) or of wave-lengths to path curvatures (for example, in the photo-electric effect) Our principle therefore requires $\alpha$ to be interpreted as the ratio of fundamental lengths, as has already been proposed[2] on less general grounds It follows that a derivation of $\alpha$ must show how assumptions containing explicitly or implicitly one fundamental length, and no arbitrary pure numbers determinable only by experiment, can account for the presence in current theory of several fundamental lengths, compare Heisenberg's idea[3] that "the introduction of a fundamental length may be bound up with a new fundamental modification of the formalism"

This suggests that in a future theory lengths may enjoy a more fundamental status than times This need not conflict with relativistic invariance within its valid field, that is, where four co-ordinates are used, for the new theory may take advantage of the fact that in quantum-mechanical stationary states there is no observable time co-ordinate

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[1] A fuller treatment, with references on lengths, will appear in *B J Phil Sci*, 1

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## Decay Energy of Beryllium-8 Nuclei observed in Cosmic Ray Stars

DURING the examination of about three thousand cosmic stars in Ilford *G*5 plates 200 $\mu$ thick, exposed at balloon altitude, we observed in several cases two prongs of comparable length, making a small angle with each other, ending in the emulsion and looking like $\alpha$-particles of about 10–20 MeV

One may suppose that such pairs are the decay products of beryllium-8 nuclei, ejected from the nucleus and disintegrating before travelling an observable distance, according to the known reaction $Be^8 \rightarrow 2He^4 + Q$

On this assumption, the kinetic energy $Q$ of the two $\alpha$-particles in the centre-of-mass system can be easily computed from the range of the $\alpha$-particles and the initial angle of their tracks[1]

A rather narrow band of energy for the value of $Q$ was found about 100 keV (16 pairs between 63 and 100 keV) A broader and lower peak was also observed around 600 keV (12 pairs between 500 and 750 keV) Only four cases were found outside these two peaks

In the 100-keV band we have six events which are readily analysed, corresponding to $Q = 76$, 94, 89, 91, 77 and 92 keV The main cause of error is, in most cases, the difficulty in measuring the angle, this is principally due to the scattering of the tracks The estimated error ranges from $\pm$ 9 keV to $\pm$ 19 keV

In ten other events, for which the length of the tracks did not allow a definite identification of the particles, the measured values of $Q$ vary from 63 to 100 keV, with possible errors ranging from $\pm$ 25 to $\pm$ 50 keV

The decay energy of beryllium-8 in the ground-state has already been measured by various authors, using other methods Recent results are those of Hemmendinger[2] (103 $\pm$ 10 keV), and Tollestrup, Fowler and Lauritsen[3] (89 $\pm$ 5 keV)

Therefore, the 100-keV peak we have observed can be attributed to beryllium-8 nuclei, emitted in the ground-state Our measurements give a value $Q = 85 \pm 10$ keV, which is in good agreement with the previous results

The broader band around 600 keV may indicate the existence of some other nuclear process

Sincere thanks are due to Prof Leprince-Ringuet for his advice and direction, to the balloon staff of the laboratory of the École Polytechnique, and to Françoise Bousser and Mady Rougeul for the preliminary examination of the plates

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Laboratoire de l'École Polytechnique,
Paris July 9

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## Slow Neutron Cross-Sections of Molybdenum and Bromine

THE total neutron cross-sections of molybdenum and bromine have been measured between 0 05 and 10 eV using a crystal spectrometer, and between 0 0025 and 0 1 eV using a mechanical time-of-flight spectrometer The crystal spectrometer is of the type described by Sturm[1] using the (110) planes of a calcium fluoride crystal in transmission The mechanical spectrometer is similar to the one described by Brill and Lichtenberger[2] Both instruments use the Harwell pile as a source of neutrons

The molybdenum cross-section was measured using a $2\frac{1}{2}$-in square piece of molybdenum sheet (15 7 gm per cm $^2$) which had been produced by rolling bars prepared by powder-metallurgy technique (The sheet consisted of several thicknesses of 99 97 per cent pure molybdenum foil supplied by Johnson, Matthey and Co, Ltd) The total cross-section as a function of energy is shown in Fig 1 In the region from 0 0025 to 0 03 eV the elastic scattering cross-section has been calculated from the theory of the transmission of slow neutrons through micro-crystalline materials[3], and the theoretical curve shown has been obtained by adding to these values the absorption cross-section

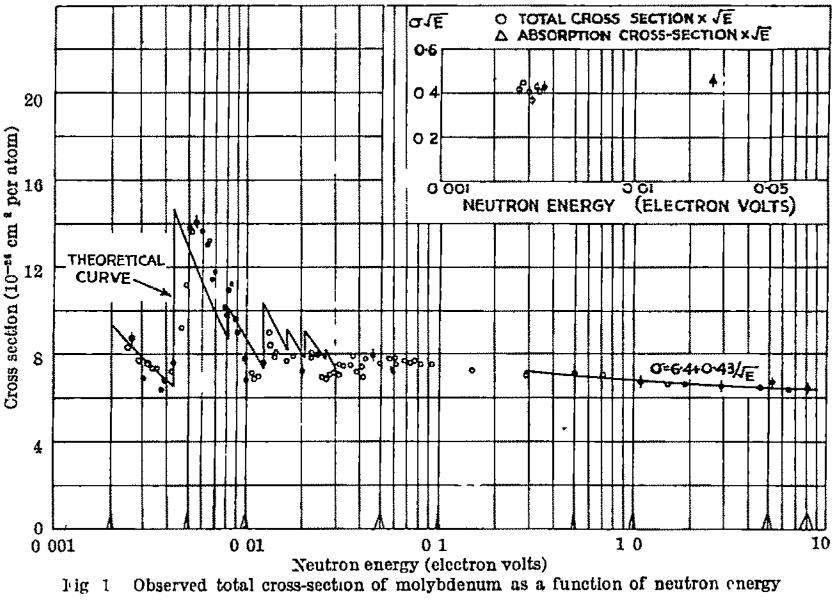

Fig 1 Observed total cross-section of molybdenum as a function of neutron energy

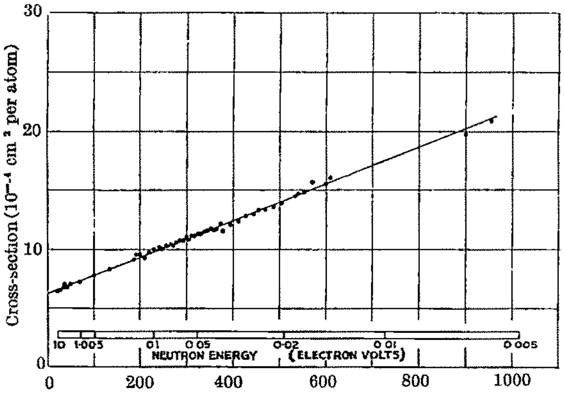

Fig 2 Observed total cross-section of bromine as a function of neutron energy The best $1/v$ line is $\sigma = 6·2 + 1·1/\sqrt{E}$ barns

deduced from the experimental results It can be seen that the experimental points are in fair agreement with the theoretical curve, but that in the region of 0·005 eV there is a difference of 10–15 per cent This is probably due to a preferred orientation of the crystals in the direction of rolling, which has been observed by X-ray analysis

The absorption cross-section of our sample at 0·025 eV has been measured by E Lockett[4] using the pile oscillator method, and a value of 2·95 ± 0·15 barns obtained Assuming the absorption cross-section follows a $1/v$ law, its value below 0·004 eV obtained from this result is approximately equal to the measured total cross-section (see inset to Fig 1) Hence the incoherent scattering (due to spin and isotope effects) and the inelastic scattering cross-sections must be less than 0·3 barn The theoretical value for the inelastic scattering cross-section at this point is 0·15 barn

It can be assumed that above 0·25 eV the total scattering cross-section becomes constant, and from 0·25 to 10 eV. the experimental points are best fitted by the equation

$$\sigma_t = 6·4 + \frac{0·43}{\sqrt{E}} \text{ barns} \qquad (1)$$

The second term in this equation represents the absorption cross-section and is equal to the total cross-section below 0·004 eV The best value of the absorption cross-section at 0·025 eV deduced from all our data is 2·7 ± 0·1 barns, which is in reasonable agreement with values of 2·4, 2·9 and 2·7 barns quoted by Ross and Story[5] The constant term in equation (1) is the bound scattering cross-section, because neutrons in the energy-range in which the measurements were made cannot impart sufficient energy to the molybdenum nuclei to displace them from the lattice The free scattering cross-section calculated from this value is 6·3 barns

The bromine measurements were made on a sample of 'Analar' bromine (17·8 gm /cm $^2$) of 99·9 per cent nominal purity The total cross-section of bromine as a function of energy is shown in Fig 2, and the experimental points are best fitted by the equation

$$\sigma_t = 6·2 + \frac{1·1}{\sqrt{E}} \text{ barns.}$$

This gives a value of 6·2 ± 0·2 barns for the scattering cross-section, and 6·9 ± 0·3 barns for the absorption cross-section at 0·025 eV, in agreement with an activation measurement of 6·6 ± 1·3 barns reported by Seren, Friedlander and Turkel[6]

We would like to thank Mr. E. Lockett for his measurement of the thermal absorption cross-section of molybdenum

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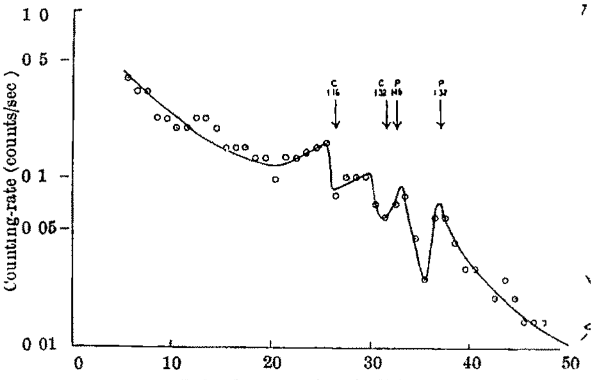
## Measurement of Gamma-Ray Energies with the Scintillation Counter

THE use of the scintillation counter as a gamma-ray spectrometer has been described by Pringle, Roulston and Taylor[1], Johannson[2], MacIntyre and Hofstadter, Cavanagh[4] and other workers However, the resolutions obtained have in general been poor, and quantitative measurements of gamma-ray energies and relative intensities difficult to make

Lack of resolution may be attributed to three main effects First, the optical efficiency of the system will vary through the volume of the crystal, and the number of photons incident upon the photomultiplier cathode will not be constant for scintillations of equal size produced at different positions in the crystal Secondly, some secondary electrons may escape from the crystal before expending all their energy, mono-energetic secondary electrons thus may not produce scintillations of uniform size Finally, the size of pulse at the photomultiplier output will be subject to large statistical variations where only a few photons are incident upon the photocathode per scintillation

These effects may be reduced by the use of small crystals of high density in a system the optical efficiency of which is as high as possible Calcium tungstate is particularly suitable having a density of 6·06 gm /c c, and the accompanying graph shows the differential curve of counting-rate against pulse-discriminator setting obtained when a small (0·124 gm) crystal of this material placed in direct contact with the envelope of an uncooled $1P21$ photomultiplier was irradiated with the gamma-radiation of cobalt-60 The pulses at the photomultiplier output were amplified in a linear amplifier (type 1008)



Differential counting-rates in calcium tungstate with 1 mC of cobalt-60 at 1 m Photomultiplier voltage 1,080, amplifier gain 1,600, mass of crystal 0·1244 gm, resolving time 200 $\mu$sec operating at a gain of 1,600, and recorded in a counting-rate meter (type 1037*A*) incorporating a pulse discriminator circuit calibrated directly in volts. The integral curve of counting-rate against pulse-discriminator setting was differentiated by taking the increment in counting-rate over each one-volt step in pulse discrimination. All counting-rates are corrected for background effects.

The twin peaks and edges due to the photo-electric absorption and Compton scattering of the two gamma-rays of energy 1·16 and 1·32 MeV are clearly resolved. The arrows give the theoretical position of these peaks and edges calculated from the observed position of the 1·32-MeV photo-electron peak, assuming a linear relationship between secondary electron energy and pulse size. The rise in the curve at low pulse discrimination may be attributed to degenerate radiation scattered from the photomultiplier housing and crystal mounting.

Similar measurements have been made using a small crystal of thallium-activated potassium iodide. Owing to the lower density (3·13), resolution is reduced, and a large increase in counting-rate appears below 20 volts discrimination owing to the single-photon phosphorescent emission of this material; it is of interest that the gradient of this portion of the curve is similar to that of the noise background of the photomultiplier, showing that it represents the emission of single electrons at the photocathode. This confirms the single-photon character of the phosphorescent emission of the luminophor[5].

Some interesting results have been obtained with radioisotopes other than cobalt-60. For example, in the case of gold-198 the presence of a low-intensity gamma-ray of energy 1·1 MeV, also reported by Pringle[6], is verified. It is estimated, by comparison with the curve for cobalt-60, that the probability of occurrence of this gamma-ray is of the order of 1 per cent.

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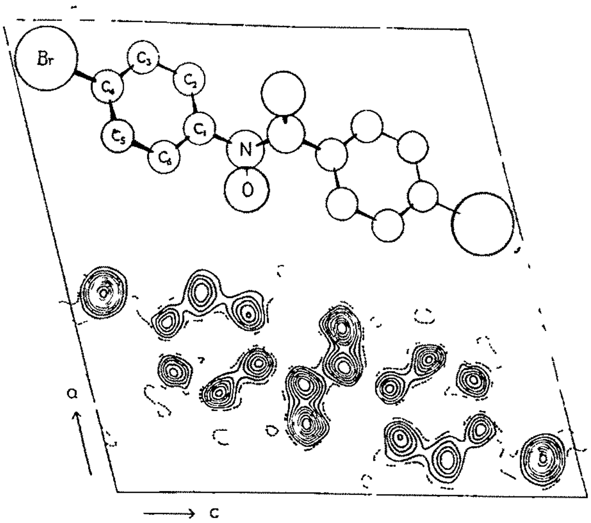
## Crystal Structure of the Dimer of *para*-Bromonitrosobenzene

AROMATIC nitrosobenzenes are dimeric in the solid state, but the nature of the link between the two halves of the molecule is not known[1]. An attempt to solve the problem has been made using the methods of X-ray analysis on crystals of *para*-chloro- and *para*-bromo-nitrosobenzene. The chlorine or bromine atom was introduced to make possible the solution of the structure by the heavy-atom method.

These two derivatives show many similarities in crystal morphology, but the crystals of the chloro-compound were triclinic and twinned; the structure determination was therefore carried out on *p*-bromonitrosobenzene. The crystals of this substance are lath-shaped, elongated along *b*; they are monoclinic, with space group $P2_1/a$, and cell dimensions

$$a = 12{\cdot}98\ \text{A},\ b = 3{\cdot}90\ \text{A},\ c = 12{\cdot}73\ \text{A}\ \text{and}\ \beta = 104°$$

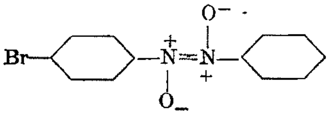


In the lower half of the cell is drawn the projection of the electron density on to the plane (010). Contours are drawn at intervals of 1 electron per A², starting with the dotted contour at 2 electrons per A². On the bromine atom the interval is 5 electrons per A². The upper half of the cell shows the arrangement of one molecule in this projection. Of the two molecules in the cell, one is tilted upwards to the left as shown, and the other is tilted downwards to the right

The unit cell contains two molecules of the dimer (molec. wt. 372·0). It also contains the asymmetric unit repeated four times, which shows that the two halves of the molecule are identical, and are related by a centre of symmetry.

Patterson and electron-density maps were calculated for projections on to the (010) and (100) planes. From these the general structure of the dimer is clearly seen. The accompanying diagram shows the projection of the electron density on to (010). So far as has been ascertained at present, the bromine atom the benzene ring and the nitrogen atom are in the same plane, tilted at a slight angle from the plane (010), and the bonds from the nitrogen atom to the carbon atom, the oxygen atom, and the other nitrogen atom seem also to be planar but tilted at an angle to the benzene ring.

The second projection calculated (not shown here) is poorly resolved, and from this it is difficult to assign accurate *y*-co-ordinates to the atoms. Hence, there is a considerable degree of uncertainty in the positions of some atoms, notably oxygen and nitrogen, the two that are most interesting. By making use of the (010) projection and of the geometry of the benzene ring, the distance $C_4$—Br may be given as 1·88 ± 0·04 A., which agrees excellently with the value 1·89 ± 0·03 A. obtained by Clews and Cochran in a bromopyrimidine; similarly, $C_1$—N is calculated as 1·40 A., in agreement with the value 1·41 A. in *trans*-azobenzene[3]. If the bonds from the nitrogen atom are assumed planar, with an angle of 120° between them, the calculated bond-length for N—N is 1·36 A. and for N—O is 1·43 A. Comparison with the second projection suggests, however, that the bond angles are not quite identical and that the bond-lengths are rather shorter—probably N—N about 1·31 A. and N—O about 1·35 A., very similar to those in the dinitrososulphite ion[4]. In any event, the N—N bond-length lies between the values for a single bond, 1·47 A.[5], and a double bond, 1·23 A.[3], while the N—O link is more nearly single bond in character; compare N—O in hydroxylamine, 1·45 A.[6], and in trimethylamine oxide, 1·36 A.[7] In terms of bond diagrams,



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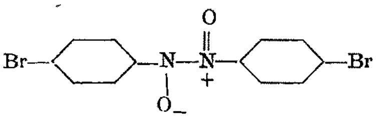

II

structure I would appear most nearly to represent the bond distribution, probably with some contribution from structures of the type of II (compare Hammick, Plant and others[1])

We are very grateful to Mr D Ll Hammick, who suggested this problem to us

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## Lattice Parameters of Martensite and of Austenite

THE lattice parameters of martensite and austenite in steels (carbon content varying from 0 57 to 1 74 per cent) have been extensively studied, but considerable discrepancies exist in the values obtained by different investigators The quenching temperatures used, however, differed, and quite often are not quoted Some authors attribute the discrepancies in the lattice constants to the surface decarburization of the specimen[1] It is significant that the diameters of the X-ray cameras used by the majority of previous experimenters were less than 9 cm

In the present investigations, the lattice parameters were established for steels containing 1 25, 1 20, 0 90, 0 89, 0 75 and 0 45 per cent of carbon A detailed account concerning the chemical analysis, the heat treatment, preparation of the specimens and the X-ray technique has been given in previous communications[2] X-ray diffraction photographs were taken both with 9-cm and 19-cm Debye–Scherrer cameras, using cobalt radiation and an iron filter. The homogeneity of the specimens was examined in some cases by using different radiation The results of the measurements of the lattice parameters are summarized in the accompanying table

The figures obtained for the lattice spacing of austenite satisfy the Dannatt–Wrażej's straight-line equation[3], and the existence of retained austenite in quenched steel with 0 45 per cent carbon entirely confirms the recent findings of other investigators[4] Further work concerning the influence of very low temperatures on the physical properties of the specimens is in progress

| Carbon (per cent) | Martensite | | | Austenite *a* parameter (A) |
|---|---|---|---|---|
| | *c* Parameter (A) | *a* Parameter (A) | *c/a* | |
| 1 25 | 3 008 | 2 842 | 1 058 | 3 6043 |
| 1 20 | 3 005 | 2 843 | 1 057 | 3 6020 |
| 0 90 | 2 963 | 2 847 | 1 041 | 3 5884 |
| 0 89 | 2 962 | 2 849 | 1 040 | 3 5879 |
| 0 75 | 2 939 | 2 850 | 1 031 | 3 5816 |
| 0 45 | — | — | — | 3 5680 |

I wish to thank Prof C W Dannatt, head of the Department, for providing the laboratory facilities, Dr A J E Welch, of the Chemistry Department of this College, for the use of X-ray apparatus, and my assistant, Mr R Sidorowicz, for help during the work

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## Absorption of Ultrasonics in Liquids from Thermal Considerations

THE thermal effect of high-frequency sound waves passing through a liquid has been studied by a number of authors, particularly by Richards[1] and Mastagli[2] Their interest was, however, limited to the determination of rise of temperature in the liquid, and to relating that rise with chemical constitution Further, their investigations were conducted only at the exact resonant frequency of the crystal In our experiments, we have studied the heating effect produced in the liquid as the frequency of the driving voltage is continuously varied around the fundamental We have thus another method of studying the resonance condition of the vibrating crystal through the production of heat

The experiments were conducted with a quartz plate having the fundamental at 420 kc/sec placed in the liquid contained in a double-walled calorimeter The usual corrections for the pronounced dielectric heating of the liquid and for radiation loss were made Seven organic liquids were studied and graphs were drawn for each liquid relating the thermal output with frequency around resonance The results of our investigations at the fundamental frequency are given in the accompanying table, the heat output shown being that at peak resonance

| Liquid | Heat output in calories | $\alpha/f^2 \times 10^{17}$ (calc )* | Heat output taking that in carbon tetrachloride as unity | $\alpha/f^2$ taking that of carbon tetrachloride as unity |
|---|---|---|---|---|
| Carbon tetrachloride | 148 4 | 20 4 | 1 00 | 1 00 |
| Nitrobenzene | 109 2 | 13 4 | 0 80 | 0 74 |
| Ethyl acetate | 73 6 | 8 3 | 0 49 | 0 41 |
| Toluene | 68 0 | 8 0 | 0 46 | 0 39 |
| Benzene | 63 0 | 8 0 | 0 42 | 0 39 |
| Xylene | 46 0 | 7 1 | 0 31 | 0 34 |
| Carbon disulphide | 38 7 | 5 0 | 0 27 | 0 26 |

* By the Stokes–Kirchhoff formula

These results show that the quantity of heat produced in the liquids follows the order of their sound absorption  Further, the very close parallelism between the last two columns is noteworthy  It is obvious, therefore, that at least at the frequency under investigation, sound absorption, as interpreted by production of heat, follows the classical absorption formula

Our results show that a larger amount of heat is produced in carbon tetrachloride than in benzene or carbon disulphide, and their ratios are in strict proportion to their coefficients of absorption, as they should from theoretical considerations  But it has been shown by other investigators[3], using different methods, that benzene and carbon disulphide exhibit anomalous absorption at higher frequencies of the order of 5 Mc /sec and above  This would indicate departures from their proportionality, which is not the case here  It appears, therefore, that this anomalous absorption observed at these frequencies for the two liquids does not exist, at any rate at 420 kc /sec and perhaps thereabout

Details of this work will be published elsewhere, further work on similar lines using higher frequencies is in progress

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## A Venn Diagram Analogue Computer

PROMPTED by the thought that a computer for the Boolean algebra should be of value, an electronic Venn diagram analogue computer (abbreviated to 'VENDAC' locally) has been devised  The computer translates the symbolism of the algebra of classes into coded pulses rather than relay contact positions

The classes *a*, *b*, *c*, etc , of the Venn diagram are represented by square wave-trains of periods *T*, *2T*, *4T*, etc , respectively, which are of equal amplitude, and are synchronized  In practice, the square waves operate 'gates' which pass or stop a rectangular wave train of period *T*/2  The sub-class *abc*, for example, is then represented by coincidence of pulses from the *a*, *b* and *c* square waves  By choosing the periods of the square waves as indicated, all possible sub-classes are included  The universal bounds 1 and 0 are represented by a rectangular wave of period *T*/2 and zero signal respectively

Units performing operations analogous to the operations of the algebra are interconnected to establish polynomials, equations, and inequations, and the 'solution' can be made to appear on an oscilloscope screen

The equivalents of the operations 'union' and 'intersection' are performed by non-additive mixers and coincidence circuits respectively. Circuits are provided to give an output signal which is the 'negative' of the input, that is, which yield the output 'not-*a*' for an input '*a*'  VENDAC contains units each of which may, by operating a switch, be made to perform any of these operations  Anti-coincidence circuits, each having a pair of input terminals, but with a common output terminal, allow equations and inequations to be set up  Anti-coincidence pulses at a pair of terminals establishing inequality yield a positive pulse of amplitude *A* at the output terminal, while anti-coincident pulses at a terminal pair establishing an equality give a negative pulse of amplitude *A*/2  The common output is led to the vertical-deflexion plates of an oscilloscope  A horizontal, linear time-base is synchronized with the period of the square wave of longest duration , for example, if only three classes, represented by waves of periods *T*, *2T* and *4T*, are considered, the period of the horizontal sweep is *4T*  Each segment of the time-base of duration *T*/2 is identified with a sub-class by markers fixed to the oscilloscope screen  The existence or non-existence of a sub-class is then indicated by the presence of a positive pulse of amplitude *A* or a negative pulse of amplitude *A*/2 in the appropriate position  The occurrence of a positive pulse of amplitude *A*/2 indicates a 'contradiction' in the equations, while the absence of a deflexion at a given position means that nothing is known about the corresponding sub-class  The pattern on the oscilloscope screen is readily translated into a literal solution

The manner in which the solution may be 'read' electronically, rather than visually, and the manner in which the multi-purpose technique may be introduced when the number of classes is large, are easily seen. Numerical problems and problems involving probability will be solved by adding circuits for integration and arithmetic operations, and automatic gain-controlled amplifiers to 'amplitude-modulate' the pulse trains

Work on an experimental computer for a maximum of four classes is in progress, and the possibility of extending the technique to the algebra of a many-valued logic is being investigated

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## Solubilities of the $\alpha_{II}$- and β-Forms of Synthetic Polypeptides: Evidence for an $\alpha_{II}$–β Transformation in the Amorphous Phase

IN previous communications[1,2] from these Laboratories, it has been shown that the molecular chains of a number of synthetic polypeptides can exist in folded and extended configurations, and the X-ray and infra-red evidence which has accumulated so far is entirely consistent with the view that the folded form has the $\alpha_{II}$-structure proposed by Ambrose and Hanby[3]  One purpose of this note is to bring forward evidence of a different kind which has a bearing on the structure of the molecular fold

We have shown that in many cases the two forms are readily interconvertible , in particular, a complete transformation to the extended β-modification can be effected by treating the folded polymer (which we shall call the $\alpha_{II}$-polypeptide) with formic acid  Some $\alpha_{II}$-polypeptides with hydrocarbon side-chains are soluble in non-polar liquids, for example, benzene or carbon tetrachloride , the copolymer (degree of

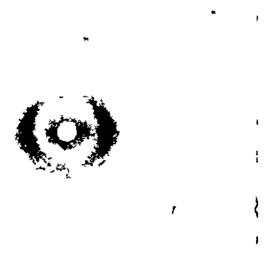

Fig 1 X-Ray photograph of oriented fibres of the copolymer of DL-$\beta$-phenylalanine and DL-leucine, after treatment with acetic acid $D = 4$ cm Copper $K_\alpha$ radiation

polymerization approximately 500) of DL-β-phenylalanine and DL-leucine ($A$) is an example of this After conversion to the β-form by formic acid, the polymer was found to be completely insoluble in benzene or carbon tetrachloride at room temperatures Experiments, which will be fully described elsewhere, have shown that this change in solubility cannot be the result of salt formation between the acid and the end amino-groups of the polymer

The differential solubility probably results from the different disposition of the hydrogen bonds in the two forms In the $\alpha_{\text{II}}$ fold, the hydrogen bonds are all intra-chain, and it is therefore not surprising that the $\alpha_{\text{II}}$-form of a polypeptide such as copolymer $A$ is soluble in non-polar liquids On the other hand, the hydrogen bonds of the idealized β-form, being exclusively inter-chain, can act as cross-links, and might be expected to make this form insoluble in non-hydrogen bonding liquids The β-polymer is, however, soluble in some liquids which can break hydrogen bonds, for example, chloroform and *m*-cresol. We feel that these results show that the configuration of the folded polypeptide is not the same as that proposed by Astbury and Bell[4] for α-keratin, in which at least two-thirds of the hydrogen bonds are not internally satisfied This view is further strengthened by the results described later, which show that a partial transformation to the β-form is sufficient to produce insolubility in non-polar liquids

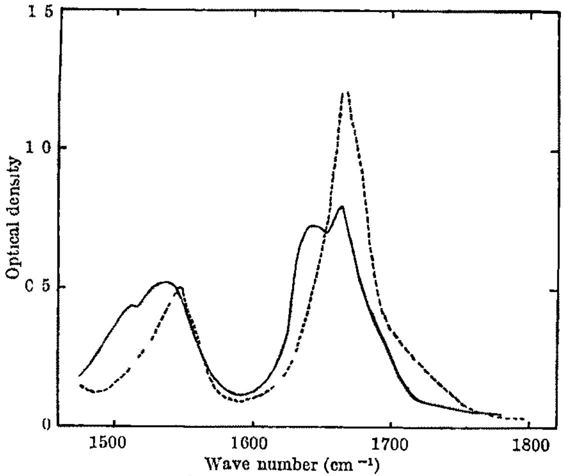

Fig 2 Infra-red absorption spectra of a film of the same polypeptide before and after treatment with acetic acid (broken and full curves respectively)

We have previously reported[1] that carboxylic acids, other than formic, have little or no effect on the X-ray diagrams of polypeptide fibres Fig 1 is an X-ray photograph of oriented fibres of copolymer $A$ which had been treated with glacial acetic acid for three minutes So far as can be seen, it is a pure $\alpha_{\text{II}}$-diagram with polar and equatorial spacings identical with those given by the original material. We now find, however, that a number of carboxylic acids, for example, acetic, propionic, *n*- and *iso*-butyric and *n*- and *iso*-caproic, can render fibres of copolymer $A$ completely insoluble in benzene at room temperatures The insolubility was again not connected with salt formation, and suggested that some transformation to the β-form had taken place

This was confirmed by infra-red examination of a similar specimen of the polymer Fig 2 shows the absorption spectra in the neighbourhood of 1,650 cm$^{-1}$ The broken curve refers to the original copolymer, and shows a single sharp peak at 1,665 cm$^{-1}$ The full curve is the spectrum of the material after treatment with acetic acid, and shows a double peak in the same region with maxima at 1,665 and 1,645 cm$^{-1}$ respectively The transformation $\alpha_{\text{II}} \rightarrow \beta$ has already been shown by Ambrose and Elliott[2] to be associated with a similar change in the CO stretching frequency in a number of polypeptides, the β-form giving rise to the peak at the lower frequency A corresponding frequency shift in the NH deformation frequencies around 1,540 cm$^{-1}$, also reported by Ambrose and Elliott, is seen in Fig 2 If the absorption coefficients of the two forms are not very different, these results suggest that after treatment with acetic acid about one-third of the polymer is in the β-form Since the latter does not appear in the X-ray photograph, it must be in the amorphous phase, and has probably been produced mainly from the amorphous $\alpha_{\text{II}}$-phase It would seem that acetic acid, unlike formic, only penetrates the amorphous phase of the polymer readily.

The possibility of effecting a transformation in the amorphous region of a polypeptide opens up an interesting line of attack on the contribution of this phase to the mechanical and other properties of fibres

We are indebted to Dr A Elliott of these Laboratories for the infra-red absorption spectra of Fig 2

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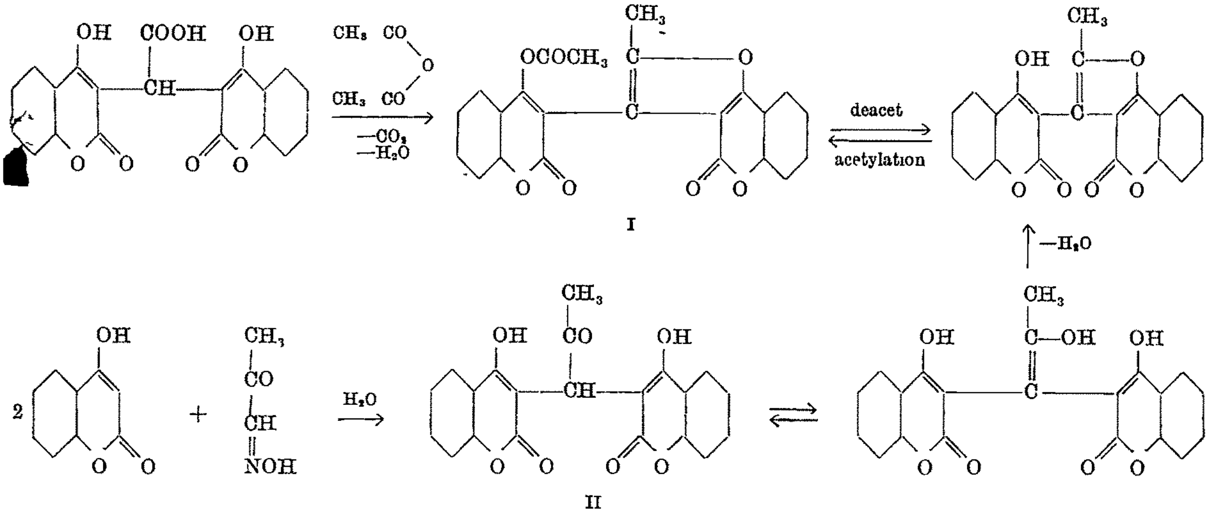
## A New Powerful Blood Anticoagulant

In an effort to elucidate the mechanism of reaction of di(4-hydroxycoumarinyl-3)acetic acid, called by us 'pelentanic acid', in boiling acetanhydride[1] (I), we prepared di(4-hydroxycoumarinyl-3)propanone by condensation of two molecules of 4-hydroxycoumarin



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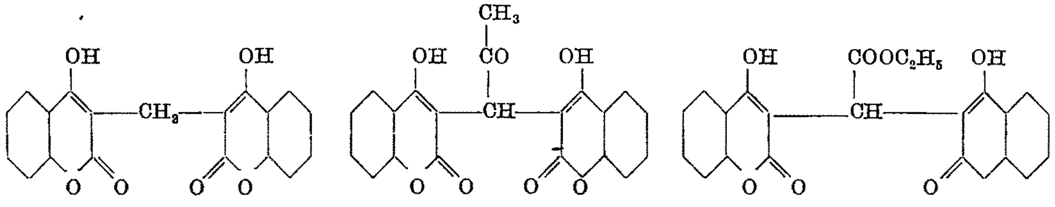
II



Dicoumarol

Di(4-hydroxycoumarinyl-3) propanone

'Pelantan-Spofa'

III

with one molecule of *iso*nitrosoacetone in a water solution (II)

The enol-form of this new substance gives with anhydrating agents the same product as we obtained by boiling 'pelentanic acid' in acetanhydride and deacetylating the acetyl-derivative formed (II) Indeed, the two synthetic methods led to identical final products

The structure of di(4-hydroxycoumarinyl-3)propanone is in some ways similar to that of dicoumarol, and in others to 'Pelentan-Spofa[2]

As we expected, the new substance has a powerful anticoagulant activity in rabbits (Quick's method) like 'Pelentan-Spofa' Its toxicity is very low, and like 'Pelentan-Spofa' it causes in oral application an earlier onset and shorter duration of hypoprothrombinæmia than dicoumarol

A detailed study of the above reactions, and of the chemical and physiological behaviour of the new substance, will be published later We are indebted to Mrs Francová and Miss Holubová for the biological tests

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## Preparation and Biological Activity of Adrenoerythrin (? Adrenalinquinone)

IN the course of experiments carried out to study the inversion mechanism of adrenalin action on the uterus, I found, in 1945 [1], that when this hormone became oxidized (auto-oxidation in water made alkaline with sodium hydroxide) a red substance occasionally appeared, which preserved intact the hypertensive action of adrenalin and, therefore, could not be the adrenochrome obtained by Green and Richter in 1936 More recently, I have again had occasion to verify the existence of this substance, which I have called 'adrenoerythrin', and a paper is now in course of publication which confirms my previous findings[2] Previously, I have not been able to obtain this substance systematically because of the large number of factors which influence the auto-oxidation of adrenalin The object of the present communication is to describe a method by which it is possible to obtain the substance in question regularly, and to set forth some of its properties

I believe[1,3] that adrenoerythrin is probably the intermediate adrenalinquinone between adrenalin and adrenochrome The existence of adrenalinquinone has been admitted as a logical step in the formation of adrenochrome , but, so far, it has not been possible to obtain it in a pure and solid form in which it could be chemically identified Its biological properties are totally unknown, except for those which I assign to adrenoerythrin, which, in my opinion, can be identified with it The method explained below was suggested to me, in its broad lines, by Prof Lavollay in a recent conversation, and it is merely a variant of the technique described by McCarty for obtaining adrenochrome.

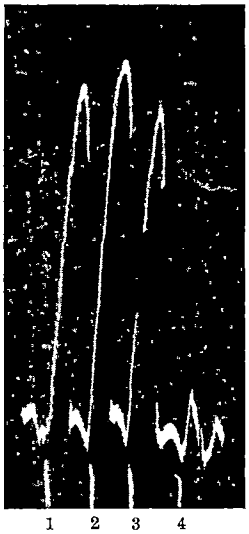

Fig 1 Effect of 20 γ of (1) adrenoerythrine, (2) adrenaline, (3) decoloured adrenoerythrine, and (4) decoloured adrenochrome upon blood pressure of the 'spinal' cat

*Method* Dissolve 250 mgm of adrenalin in 25 ml of normal sulphuric acid, and add 1 gm lead oxide ($PbO_2$), shake while cold for two minutes and filter the mixture The liquid which filters through is of an intense yellowish-red colour, and if left for twenty-four hours it turns brown, becoming eventually practically black The intensity of the colour developed, compared with that produced by the same quantity of adrenochrome, is much less intense and of a yellower tone Because of its great instability, it has not been possible to crystallize this substance

If sodium hyposulphite in a fresh aqueous solution ($Na_2S_2O_4$) is added, the substance becomes practically wholly discoloured and the discoloured product has no green fluorescence, contrary to what occurs with adrenochrome discoloured in the same way The yellowish-red solution obtained does not give a green colour with iron perchloride, whereas the solution discoloured with $Na_2S_2O_4$ produces a greenish colour, which seems to indicate that the adrenalin has become regenerated by the reduction This does not occur with discoloured adrenochrome

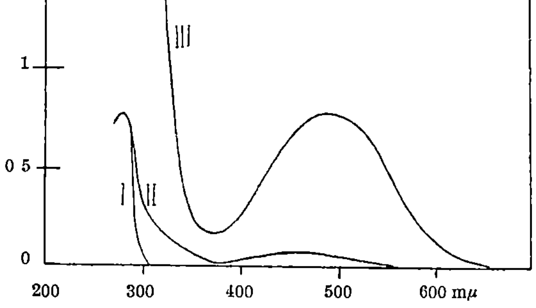

Fig 2 Absorption curves obtained in a Beckmann spectrophotometer I, adrenaline (1 20,000), II, adrenoerythrine, and III, adrenochrome

The biological activity (hypertensive) in spinal cats has also been investigated and found to be practically equal to that of the same quantity of adrenalin This equality of action is found both in the red substanc[illegible] thus obtained and in the same substance after being discoloured with hydrosulphite, showing that adrenoerythrin is as active as adrenalin itself (Fig 1) The fact that this coloured compound—which, according to our results, seems to be adrenolinquinone—preserves the whole of the biological activity of adrenalin makes me identify it with the adrenoerythrin which I described in previous papers

I believe that this hypertensive activity of adrenoerythrin, which is of the same magnitude as that of adrenalin, invalidates the old view that oxidation of the phenol groups of adrenalin renders it inactive I have not been able to ascertain whether the prod of adrenalin oxidation thus obtained is a doul quinone or a semiquinone, or whether oxidation takes place in the oxhydryl of the lateral chain, although this last suggestion is improbable

If the classical formula of adrenochrome be accepted, it is only logical to think that the substance under review is a quinone, since the method of preparation is the same as for adrenochrome (unheated) But if Harley-Mason's views[3] are admitted, according to which adrenochrome has only a cetone group, it may be a semiquinone

Absorption curves for adrenalin, adrenoerythrin and adrenochrome, obtained in a Beckmann spectrophotometer, are shown in Fig 2

A full discussion of these results will be given in a forthcoming paper[4]

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## Nucleic Acid Content of Tumour Cells

It has been suggested[1,2] that the quantity of deoxypentosenucleic acid is constant for different somatic cells in the same species On this assumption, the deoxypentosenucleic acid content of different tumour cells can be compared with that of normal cells from the same species Many efforts have been made to compare the deoxypentosenucleic acid content of homologous normal and neoplastic tissues (see reviews in refs 3 and 4) The results are rather divergent, several authors having reported an increase in deoxypentosenucleic acid in tumour cells, whereas others failed to observe any difference We have found the Ehrlich ascites tumour of mice to be a good material for determinations of the average nucleic acid content of a single tumour cell[5,6] and have found the deoxypentosenucleic acid content of such cells to be about twice as great as that of normal mouse cells[6,7]

Recently, by the courtesy of Prof C Krebs (Aarhus), we were able to obtain the Krebs–Rask–

Nielsen–Wagner sarcoma[8] which also is able to grow intraperitoneally and produces a tumour-ascites, composed mainly of the typical lymphoblast-like tumour cells We have determined the average nucleic acid content of these cells by the same methods as used previously for the Ehrlich ascites tumour The results are shown in the accompanying table

| | Deoxypentosenucleic acid per cell (10 $^{5}$ μgm ) | Pentosenucleic acid per cell (10 $^{5}$ μgm ) | $\frac{\text{Pentosenucleic acid}}{\text{Deoxypentosenucleic acid}}$ |
|---|---|---|---|
| Normal mouse cells (for references see ref 6) | 0 5–0 8 | | |
| Ehrlich ascites tumour (mean of 65 determinations) | 1 42 | 2 62 | 1 84 |
| Krebs sarcoma (mean of 15 determinations) | 0 70 | 0 58 | 0 83 |
| ome solid nouse tumours (ref 3) | | | 0 57–0 90 |

As is apparent from the table, the deoxypentosenucleic acid content of the Krebs sarcoma is within the range of the values for normal cells, whereas the Ehrlich carcinoma, growing under similar conditions and determined by the same methods, shows an increased value Hence this small material of two tumours shows that different tumours may behave differently as to the average deoxypentosenucleic acid content of the cells and that this may be a factor in producing the divergencies in the literature

Concerning the pentosenucleic acid content of the two ascites tumours, it is difficult to find a sound basis for comparison Schneider[3] has determined the pentosenucleic acid and deoxypentosenucleic acid content in a number of different rat and mouse tumours , the ratio of the pentosenucleic acid to the deoxypentosenucleic acid calculated from his values is roughly constant for the different tumours, lying between 0 57 and 0 90 In the case of the rat liver tumour he used, Schneider has shown that there is no significant difference between the deoxypentosenucleic acid content of the tumour nuclei and that of normal liver nuclei Assuming that the same would apply to the other solid tumours investigated by him, which show the same ratio of the two nucleic acids, a comparison of these ratios with that for the Ehrlich ascites tumour, namely, 1 84, shows that the cells of the latter contain at least four times as much pentosenucleic acid on an average as the cells of the different solid tumours investigated by Schneider On the other hand, the Krebs sarcoma, which, as we have already seen, follows the normal cells and not the Ehrlich ascites tumour as regards its deoxypentosenucleic acid content, shows a ratio of 0 83 and is thus in the range of the solid tumours of Schneider

Solid tumours contain cells with highly varying nucleic acid content, as has been shown by Caspersson and Santesson[9] Comparing the ultra-violet absorption of similarly treated Ehrlich ascites tumour and solid tumours produced by the injection of the same ascites fluid, we were able to demonstrate[6] that the Ehrlich ascites tumour contains cells of uniform and comparatively high ultra-violet absorption (257 mμ) which correspond to the *A*-cells with high nucleic acid content[9] in the solid tumour Since solid tumours consist mainly of intermediate and *B*-type cells and only a small number of *A*-cells, the high average nucleic acid content of the Ehrlich ascites tumour cells found chemically can be explained

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## Role of Zinc in Metabolism

Zinc is known to be a component of carbonic anhydrase[1] and is thought to be part of uricase[2] It also is a non-specific divalent activator of several other enzymes The striking effect of zinc deficiency on organic acid formation by fungi ('zinc shunt') has recently been reviewed[3] Some older evidence in the literature and a generalized interpretation given for the zinc effect made it possible to predict[4] that similar effects would be obtained with deficiencies of other nutrient elements This has been confirmed[5].

Additional evidence that zinc is a determinative factor in carbohydrate metabolism has now been accumulated for two well-known acid-producing fungi, a fumaric acid-producing strain of *Rhizopus nigricans* and a citric acid-producing strain of *Aspergillus niger*

Washed shake mycelium was mainly used , zinc-deficient medium was obtained by Steinberg's[6] calcium carbonate method Iron, manganese and copper were added to the purified medium Mycelium was considered zinc-deficient only when less than half the yield of mycelium was obtained as compared to a zinc-sufficient control Other details are precisely those described elsewhere[7,8]

*Growth experiments* When equal weights of mycelial inoculum, obtained from zinc-sufficient (*ZS*) medium and from zinc-deficient (*ZD*) medium, were inoculated into *ZS* medium, the *ZS* inoculum rapidly attained maximum growth-rate (as indicated by periodic dry-weight measurements), but the *ZD* inoculum always required 10–15 hr longer to attain maximum growth-rate Since the ionic zinc in the test medium failed to restore the growth-rate of the *ZD* inoculum promptly, this indicated that zinc must be built up into organic combination, or that ionic zinc is necessary for the synthesis of some growth-limiting substance, and that this synthesis occurs during the observed lag period Extracts of *ZS* mycelium, yeast extract and other natural materials, dialysed and undialysed, did not shorten the lag , this indicated that the essential substance was a large molecule and probably heat-labile In short-time growth-experiments in Warburg respirometers, using as the criterion of growth-rate oxygen uptake with glucose as the substrate, the importance of synthesis before the lag could be eliminated was made evident by the fact that assimilable nitrogen had to be present to restore *ZD* mycelium, ionic zinc and the other nutrient elements were ineffectual Also, oxygen was essential, the effect was absent anaerobically in the presence of assimilable nitrogen

*Respiration experiments* The endogenous respiration ($Q_{O_2}$) of zinc-deficient mycelium was slightly less than that of zinc-sufficient mycelium, and exogenous respiration of several substrates (glucose, ethanol, acetate and malate) was slightly higher in *ZD* mycelium Oxidative assimilation of glucose was no different in *ZS* and in *ZD* mycelium

*Fermentation experiments* In contrast to the dubious significance of the aerobic respiration differences between zinc-sufficient and zinc-deficient mycelium on glucose there were striking differences in anaerobic respiration (fermentation), as displayed by carbon dioxide evolution measured manometrically (Table 1)

TABLE 1

| Experiment | Zinc-deficient mycelium | | Zinc-sufficient mycelium | |
|---|---|---|---|---|
| | $Q_{CO_2}$ | $Q^{glucose}_{CO_2}$ | $Q_{CO_2}$ | $Q^{glucose}_{CO_2}$ |
| (1) *R nigricans* | 0 | 9 8 | 2 8 | 73 5 |
| (2) ,, ,, | 0 | 9 6 | 0 | 62 6 |
| (3) *A niger* " | 0 | 1 0 | 1 5 | 10 0 |

*Pyruvic carboxylase experiments* The fermentation effect was traced to pyruvic carboxylase in *Rhizopus nigricans*, though other enzymes cannot be excluded Tests with *Aspergillus* are in the early stages Desiccated *R nigricans* mycelium is more permeable to pyruvic acid than living mycelium Zinc-deficient and zinc-sufficient mycelium dried overnight *in vacuo* over phosphorus pentoxide were tested for pyruvate carboxylase activity as judged by carbon dioxide evolution from pyruvic acid at *p*H 6 3 in the absence of oxygen In numerous trials, *ZD* mycelium never evolved carbon dioxide at more than a negligible rate, whereas *ZS* mycelium evolved large amounts Acetaldehyde was identified as the other product of the decarboxylation by preparation of the 2,4-dinitrophenylhydrazone from the neutral volatile fraction Cell-free juices obtained by grinding air-dried living mycelium with sand with a mortar and pestle behaved similarly juices from *ZD* mycelium always had negligible pyruvic carboxylase activity whereas its *ZS* counterpart displayed $Q^{pyruvate}_{CO_2}$ values ranging from 200 to 1,800 depending on the method of preparation Ionic zinc, cocarboxylase and magnesium ions added to the deficient juice did not elicit any pyruvate carboxylase activity

*Zinc content of pyruvic carboxylase preparations* It seemed probable that pyruvic carboxylase was the substance the synthesis of which accounted for the lag in the growth experiments described above Also, a question arose as to whether pyruvic carboxylase of *R nigricans* is a zinc protein, a point all the more interesting because carbonic anhydrase also is a carbon dioxide-liberating enzyme Experiments with potassium cyanide and sodium azide as poisons for pyruvic carboxylase preparations, carried out in a manner similar to the poisoning experiments of Keilin and Mann[1] with carbonic anhydrase, did not lead to reduction in activity of the enzyme, suggesting that the enzyme may not be a zinc protein Ammonium sulphate fractionation of dialysed mycelial juice was performed to obtain preparations of different stages of purity of the enzyme, the zinc contents were determined by the growth response of *Rhizopus nigricans* to ashed samples in a virtually zinc-free basal medium. A straight-line response to increments of a standard zinc solution was obtained, and the responses of the unknown preparations were compared with the standard curve Each preparation was dialysed before testing for activity While the results (Table 2) are not wholly satisfactory, it may be seen (Exp 1 and 2) that the zinc content of the purified preparations either remained the same as the unpurified (dialysed) starting juice, or was much less (Exp 3) In either case, the content would be expected to rise with increased potency of the preparations The best gauge of the actual relations is the ratio per cent Zn/$Q_{CO_2}$ in Table 2 This expresses the zinc content with respect to enzyme activity, and in each experiment the results are clearly in the opposite direction to what one would expect if the enzyme were indeed a zinc protein However, it must be emphasized that probably the best enzyme preparation obtained still is far from pure Also i clear that substantial amounts of inert organic zinc substances are present in the crude mycelium juice

TABLE 2

| Experiment | Fraction precipitated by ammonium sulphate | $Q_{CO_2}$ | % Zinc | $\frac{\% \text{ Zn}}{Q_{CO_2}} \times 10^5$ |
|---|---|---|---|---|
| 1 | Starting juice | 710 | 0 064 | 9 0 |
| | 40 per cent | 1,636 | 0 074 | 4 5 |
| | 40 ,, * | 1,891 | 0 057 | 3 0 |
| 2 | Starting juice | 1,772 | 0 064 | 3 6 |
| | 20 per cent | 0 | 0 031 | — |
| | 30 ,, | 0 | 0 045 | — |
| | 40 ,, | 4,163 | 0 062 | 1 5 |
| | 50 ,, | 0 | 0 020 | — |
| 3 | Starting juice | 930 | 0 054 | 5 8 |
| | 20 per cent | 0 | 0 031 | — |
| | 40 ,, | 1,855 | 0 012 | 0 64 |

* This fraction was obtained by dissolving the precipitate obtained with 40 per cent saturation with ammonium sulphate, dialysing and reprecipitation at 40 per cent ammonium sulphate saturation

We may conclude that zinc is essential for the synthesis of pyruvic carboxylase in *R nigricans* even though, at present, indications are that the metal is not part of the enzyme It is possible that under conditions of zinc deficiency an inhibitor is formed

The foregoing results implement the previous mass of experimental evidence, and the interpretation that zinc plays a specific part in the utilization of carbohydrate by fungi

This work was supported by grants from Ciba Pharmaceutical Laboratories, Inc, and Merck and Co, Inc, and by a grant-in-aid from the American Cancer Society upon recommendation of the National Research Council Committee on Growth

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F W DENISON, JUN

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June 29

[1] Keilin, D, and Mann, T, *Biochem J*, **34**, 1163 (1940)
[2] Baldwin, E, "Dynamic Aspects of Biochemistry" (Macmillan, New York, 1947)
[3] Foster, J W, "Chemical Activities of Fungi" (Academic Press, New York, 1949)
[4] Foster, J W, *ibid*, pp 166, 272, 276, 394–395, and especially 167
[5] Chesters, C G C, and Robinson, G N, *Nature*, **165**, 851 (1950)
[6] Steinberg, R A, *J Agric Res*, **51**, 413 (1935)
[7] Foster, J W, and Davis, J B, *J Bact*, **56**, 329 (1948)
[8] Foster, J W, and Davis, J B, *Arch Biochem*, **21**, 135 (1949)

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 13

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m —Mr O H K Spate "The Geography of Determinism"

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Discussion on "Cybernetics" (to be opened by Mr D M MacKay)

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5 30 p m —Clayton Memorial Lecture *

Institution of the Rubber Industry, Midlands Section (in the Pavilion, Goodyear Park, Wolverhampton), at 7 p m —Mr D E Jones "What the Factory Inspector requires of the Rubber Industry"

Royal Institute of Chemistry (joint meeting with the Chelsea Polytechnic Chemical Society, at Chelsea Polytechnic, Manresa Road, London, S W 3), at 7 p m —Dr J H Schulman "The Physical Chemistry of Hæmolysis"

Society of Chemical Industry, Fine Chemicals Group (at the Royal Institution, 21 Albemarle Street, London, W 1), at 7 p m —Prof A Haddow "The Chemotherapy of Cancer"

Institution of Works Managers, Sheffield Branch (joint meeting with the Institution of Production Engineers, at the Grand Hotel, Sheffield), at 7 30 p m —"Mechanical Handling"

## Monday, November 13—Saturday, November 18

Public Works and Municipal Services (at The Olympia, Hammersmith Road, London, W 14) —Congress and Exhibition

## Tuesday, November 14

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S W 1), at 2 30 p m —Mr W Shaw "Incidents in the Life of a Sanitary Inspector" *

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 4 30 p m —Mr C G A Rosen "Significant Contributions of the Diesel Research Laboratory" (James Clayton Lecture)

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N W 8), at 5 p m —Scientific Papers

Royal Institution (at 21 Albemarle Street, London, W 1), at 5 15 p m —Dr Dorothy Hodgkin, F R S "Crystallography in Modern Science, (iii) Crystallography in Biology"

Institution of Civil Engineers (at Great George Street, London, S W 1), at 5 30 p m —Prof A L L Baker "Recent Research in Reinforced Concrete and its Application to Design"

Institution of Electrical Engineers (joint meeting of the Measurements and Radio Sections, at Savoy Place, Victoria Embankment, London W C 2), at 5 30 p m —Mr H M Smith "The Determination of Time and Frequency", Dr L Essen "Frequency Standardization"

Illuminating Engineering Society (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 6 p m —Mr C Dykes Brown "The Lighting of the New House of Commons"

Incorporated Plant Engineers, East Lancashire Branch (at the Engineers' Club, Albert Square, Manchester), at 7 15 p m —Mr H L Gloag "The Application of Colour in Industry"

Chemical Society, Northern Ireland Section (joint meeting with the Andrews Club, the Royal Institute of Chemistry and the Society of Chemical Industry, in Chemistry Lecture Theatre, Queen's University, Belfast), at 7 30 p m —Prof E L Hirst, F R S "Some Problems in the Chemistry of the Polysaccharides"

Institution of Works Managers, West Yorkshire Branch (at the George Hotel, Huddersfield), at 7 30 p m —Mr A P Young "Industrial Management and its Human and Social Implications"

## Wednesday, November 15—Thursday, November 16

Institution of Electrical Engineers, Utilization Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Conference on "Electricity as an Aid to Productivity"

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S W 1) —Autumn General Meeting

## Thursday, November 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m —Dr E Ashworth Underwood "Anatomy and the Graphic Arts" *

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S E 5), at 3 p m —Prof J Z Young, F R S "Cortical Structure and Function" *

Royal Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —"The Structure of Synthetic Polypeptides" Dr C H Bamford, Mr W E Hanby and Dr F Happey "X-Ray Investigation", Mr E J Ambrose and Dr A Elliott "Infra-Red Investigation"

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Dr E C Ellwood "Treatment of Gold Ores in South Africa and Canada", Dr J R F Joyce "Note on an Apparatus for the Experimental Investigation of Hydrothermal Replacement and Ore Deposition"

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Prof J Dieudonné "The Classical Groups"

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 30 p m —"The Seasons" (Sound films with introduction by Miss M C Simpson and Mr G J Cons)

University of London (in the Senate House, London W C 1), at 5 30 p m —Prof F A E Crew, F R S "The Biological Aspects of War" * (Further Lectures on November 23 and 30 )

Chemical Society, Hull Section (joint meeting with University College Scientific Society, in the Science Lecture Theatre, University College, Hull), at 6 p m —Sir John Lennard-Jones, F R S "Recent Theories of Molecular Structure"

Chemical Society (at Burlington House, Piccadilly, London, W 1), at 7 30 p m —Scientific Papers

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 8 15 p m —Prof J E Roberts "Problems and Possibilities in the use of Co60 for Radiotherapy"

## Thursday, November 16—Friday, November 17

Institute of Physics, X-Ray Analysis Group (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1) —Conference on "The Development and Application of Fourier Methods in Crystal Structure Analysis"

## Thursday, November 16—Sunday, November 19

British Institute of Management, in association with the Institute of Industrial Administration (at Harrogate) —Management Conference

## Friday, November 17

Biochemical Society (in the Lecture Theatre, Wright–Fleming Institute, St Mary's Hospital Medical School, Paddington, London, W 2), at 2 p m —Scientific Papers

Chemical Society, Southampton Section (joint meeting with University College Chemical Society, in the Physics Department, University College, Southampton), at 5 p m —Sir Cyril Hinshelwood, F R S "Kinetics of the Bacterial Cell"

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Lieut -Comdr J D Moore and Comdr A V Thomas "Surface Navigation in High Latitudes"

Chemical Society, South Wales Section (joint meeting with the Royal Institute of Chemistry and University College Chemical Society, at University College, Swansea), at 5 30 p m —Prof C W Davies "Ion Exchange Resins"

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p m —Sir Harry Ricardo, F R S "Supercharging of Internal Combustion Engines" (Thomas Hawksley Lecture)

North East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6 15 p m —Mr John R Shearer "A Preliminary Investigation of the Discrepancies between the Calculated and Measured Wave-making of Hull Forms"

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 6 30 p m —Dr C W Gilbert "Some Aspects of the Production of Radioactive Isotopes"

Institute of Industrial Administration, Manchester Centre (joint meeting with the North-West Region of the Institute of Economic Engineering, in the Reynolds Hall, College of Technology, Manchester), at 7 p m —Mr J A Scott "Industrial Efficiency—Management's Problem"

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p m —Dr E C Bullard, F R S "The Earth's Magnetic Field"

Chemical Society, Glasgow Section (in the Chemistry Department, The University, Glasgow), at 7 15 p m —Prof R M Barrer "Some Problems in Gas Flow and Sorption"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Mr Ralph Cory "Fifty Years at the Royal Institution"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Assistant Chemist in the Research Department at Crewe—The Superintendent (Chemistry Division), Research Department, Railway Executive, London Road, Derby (November 18)

Lecturer in the Department of Chemistry and Biology, City College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (November 18)

Research Assistant in the Department of Hæmatology, as a member of a team concerned with the investigation of hæmoglobin metabolism—The House Governor, King's College Hospital, Denmark Hill, London, S E 5 (November 18)

Assistant Lecturers (2) in the Department of Electrical Engineering (electro-technics)—The Registrar, The University, Liverpool (November 20)

Lecturer in Physiology—The Registrar, King's College, Strand, London, W C 2 (November 25)

Physicists and Electrical Engineers at a Ministry of Supply Research and Development Establishment in the South Midlands Principal Scientific Officers (*a*) to lead a team in electronics research with special reference to microwave techniques, (*b*) to lead a team engaged on development of fire control radar equipment, Scientific Officers for research and development work on Army radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 296/50A (November 25)

TECHNICAL OFFICER (woman, with a degree in chemistry and administrative and industrial experience) in the Technical and Scientific Register —The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 380/50A (November 25)

ELECTRONIC ENGINEERS and PHYSICISTS (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in and near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 294/50A (November 27)

EXPERIMENTAL OFFICER IN THE MECHANICAL ENGINEERING RESEARCH ORGANISATION (Department of Scientific and Industrial Research), for work on the effect of high pressure on the properties of materials—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting C 587/50A (November 27)

HONOURS GRADUATE IN ZOOLOGY, for whole-time research on various diseases of the adult honey-bee—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (November 28)

ASSISTANT KEEPER IN ARCHÆOLOGY AND ETHNOLOGY in the Museums Department—The Town Clerk, Municipal Buildings, Liverpool 2 (November 30)

LECTURER IN GENETICS, and a LECTURER IN MATHEMATICS, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (November 30)

PROFESSOR OF GEOLOGY—The Dean, Faculty of Science, Fouad I University, Abbassia, Cairo, Egypt (November 30)

RESEARCH OFFICERS or TECHNICAL OFFICERS FOR COAL UTILIZATION RESEARCH, Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organisation—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting No 3025 (November 30)

SENIOR RESEARCH OFFICER, Grade I, at the Ministry of Agriculture's Veterinary Laboratory, Weybridge—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1, quoting No 3336 (November 30)

SENIOR LECTURER IN PHYSICAL CHEMISTRY at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 8)

CHAIR OF PHILOSOPHY at King's College—The Academic Registrar, University of London, Senate House, London, W C 1 (December 11)

ASSISTANT KEEPER IN BOTANY in the Manchester Museum—The Registrar, The University, Manchester 13 (December 15)

CHAIR OF CHINESE ART AND ARCHÆOLOGY at the School of Oriental and African Studies—The Academic Registrar, University of London, Senate House, London, W C 1 (December 15)

SENIOR LECTURER IN MECHANICAL ENGINEERING at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 15)

SENIOR LECTURER or LECTURER IN PHYSICS, and a SENIOR LECTURER or LECTURER IN PHILOSOPHY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 16)

LECTURER IN BOTANY, a SENIOR LECTURER IN AGRICULTURAL CHEMISTRY, a SENIOR LECTURER or LECTURER IN ECONOMICS, and a SENIOR LECTURER IN STATISTICAL METHODS, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 31)

CHAIR OF PURE MATHEMATICS—The Secretary, The University, Birmingham 3 (January 1)

CHAIR OF APPLIED MATHEMATICS—The Secretary, Queen's University, Belfast (January 15)

DIRECTOR OF THE MARINE BIOLOGICAL STATION being established at Bangor to develop the facilities for the study of marine biology within the University of Wales—The Secretary and Registrar, University College of North Wales, Bangor (January 31)

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Education in 1949 being the Report of the Ministry of Education and the Statistics of Public Education for England and Wales (Cmd 7957 ) Pp ix+236+8 plates (London H M Stationery Office, 1950 ) 5*s* 6*d* net [168

Colonial Development and Welfare Acts Returns of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies, with the concurrence of the Treasury, in the Period from 1st April, 1949, to 31st March, 1950 Pp 73 (London H M Stationery Office, 1950 ) 1*s* 9*d* net [168

Colonial Office The British Territories in East and Central Africa, 1945–1950 (Cmd 7987 ) Pp iv+166 (London H M Stationery Office, 1950 ) 4*s* net [168

*British Journal of Radiology* Supplement No 2 Some Applications of Nuclear Physics to Medicine By Prof W V Mayneord Pp xii+290 (London British Institute of Radiology, 1950 ) 35*s* [178

Recommendations for the Design and Fabrication of Arc Welded Structural Steelwork, Built-up Girders and Compression Members Pp 12 (London British Welding Research Association, 1950 ) 1*s* 6*d* [178

City of Gloucester Folk Museum Guide to the Collection of Bygone Agricultural Implements By J Neufville Taylor Pp 20+4 plates (Gloucester Folk Museum, 1950 ) 9*d* [178

Creative Love By George T Hill (Fourth Annual Lecture delivered in Birmingham, Glasgow and London, 1948–49 ) Pp iii+22 (Woodford Green New Church College, 1950 ) 1*s* 6*d* net [178

A Description of the International Council of Scientific Unions Pp vi+137 (Cambridge. International Council of Scientific Unions, Caius College, 1950 ) [178

East Malling Research Station Annual Report, 1st January, 1949, to 30th September, 1949 Pp 187+21 plates (East Malling East Malling Research Station, 1950 ) 10*s* [178

Eighty-sixth Annual Report on Alkali, &c Works, covering the Year 1949 By the Chief Inspector Pp 40 (London H M Stationery Office, 1950 ) 1*s* net [178

## Other Countries

Carnegie Institution of Washington Publication 589 Maya Hieroglyphic Writing, Introduction By J Eric S Thompson Pp xvii+347+64 plates (Washington, D C Carnegie Institution, 1950 ) 7 dollars [148

Transactions of the American Philosophical Society New Series, Vol 39, Part 3 The Pottery of Marajó Island, Brazil By Helen C Palmatary Pp 259–470 (112 plates) (Philadelphia American Philosophical Society, 1950 ) 3 dollars [148

What Israel Thinks (Quarterly ) Vol 1, No 1, Summer Pp 8 (Jerusalem Israel Institution of Applied Social Research, 1950 ) Annual subscription, 2 dollars [148

Adrenal Cortex Transaction of the First Conference, November 21–22, 1949 Edited by Elaine P Ralli Pp 189 (New York Josiah Macy Jr Foundation, 1950 ) 2 dollars [148

British Guiana Report on the Geological Survey Department for the Year 1949 Pp iii+40 (Georgetown Geological Survey Department, 1950 ) 1 dollar, 4*s* 2*d* [158

South African Council for Scientific and Industrial Research Fourth Annual Report, 1948–1949 Pp 84+7 plates (Pretoria South African Council for Scientific and Industrial Research, 1950 ) [158

Indian Association for the Cultivation of Science Special Publication No 14 Distribution of Anthocyanins By Sir Robert Robinson Pp 16 1 4 rupees, 2*s* Annual Report for 1949–50 Pp ii+49 (Calcutta Indian Association for the Advancement of Science, 1950 ) [158

'Juan de la Cierva' Foundation for Technical Research its Organization and Development Pp 40 (Madrid 'Juan de la Cierva' Foundation, 1950 ) [178

Canada Department of Mines and Technical Surveys, Geological Survey Bulletin No 15 Actinocamax from the Upper Cretaceous of Manitoba, by J A Jeletsky, Sciophyllum, a New Rugose Coral from the Canadian Arctic, by P Harker and D J McLaren Pp v+43 (4 plates) 25 cents Memoir 255 Callum Creek, Langford Creek, and Gap Map-areas, Alberta By R J W Douglas (No 2493 ) Pp vii+124 1 dollar (Ottawa King's Printer, 1950 ) [178

Canada Department of Mines and Technical Surveys, National Museum of Canada Bulletin No 116 (Anthropological Series No 28) Folk-Lore of Waterloo County, Ontario By W J Wintemberg Pp vii+68 50 cents Bulletin No 117 (Anthropological Series No 29) Folklore of Lunenburg County, Nova Scotia By Helen Creighton Pp v+163 50 cents Bulletin No 118 Annual Report of the National Museum for the Fiscal Year 1948–1949 Pp v+120 (23 plates) 25 cents (Ottawa King's Printer, 1950 ) [178

Chicago Natural History Museum Report of the Director to the Board of Trustees for the Year 1949 Pp 140 (Chicago Chicago Natural History Museum, 1950 ) 1 dollar [178

Ministry of Public Works, Egypt Physical Department Paper No 46 The Nile Basin By Dr H E Hurst and R P Black Third Supplement to Vol 2 Measured Discharges of the Nile and its Tributaries in the Period 1938–1942 Pp viii+216 (Cairo Government Press, 1949 ) PT 100, 20*s* [178

Thomas Baker, Alice Baker and Eleanor Shaw Medical Research Institute Collected Papers, Vol 5, 1946–1949 27 Papers (Melbourne Alfred Hospital, 1950 ) [178

Western Australia Report of the Director of Government Chemical Laboratories for the Year 1947 Pp 28 (Perth Government Printer, 1950 ) [178

United States Department of the Interior Geological Survey Bulletin 948 E Preliminary Report on Corundum Deposits in the Buck Creek Peridotite Clay County, North Carolina By Jarvis B Hadley (Strategic Minerals Investigations, 1945 ) Pp iv+103–128 60 cents Bulletin 955-C Phosphate Deposits of the Deer Creek–Wells Canyon Area, Caribou County, Idaho By Charles Diess (Contributions to Economic Geology, 1947 ) Pp iv+61–101 45 cents Bulletin 966-D Geophysical Abstracts 139, October–December 1949 (Numbers 11442–11678) By Mary C Rabbitt, V L Slitsky and S T Vesselowsky Pp iii+253–333 25 cents Bulletin 968 Bibliography of North American Geology, 1948 By Emma Mertins Thom, Marjorie Hooker and Ruth Reece Dunaven Pp iii+309 60 cents (Washington, D C Government Printing Office, 1949–1950 ) [178

Meddelande från Lunds Astronomiska Observatorium Ser 1, Nr 170 A Study of the Absorption in NGC 5195 By Erik Holmberg Pp 12 Ser 2, Nr 127 On Quadrature Formulæ By Anders Reiz Pp 8 Ser 2, Nr 128 A Photometric Study of nearby Galaxies By Erik Holmberg Pp 56 (Lund Astronomiska Observatorium, 1950 ) [218

Unesco Middle-East Science Co-operation Office List of Scientific Papers published in the Middle-East received by this Office between 1st October 1949 and 1st March 1950 No 5, June Pp 78 (Cairo Unesco Middle-East Science Co-operation Office, 1950 ) [218

Publications of the Dominion Observatory, Ottawa, Vol 14 Bibliography of Seismology No 6 Items 7132–7221, July to December 1949 By W G Milne Pp 135–146 (Ottawa King's Printer, 1950 ) 25 cents [218

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia Verhandelingen No 37 Regenval in Indonesië (Rainfall in Indonesia) Door Prof Dr H P Berlage, Jr Pp 212 (Batavia Koninklijk Magnetisch en Meteorologisch Observatorium, 1949 ) [218

## Catalogues

Siemens Engineering Bulletin No 252, May The Type 1200 High-speed Motor Uniselector Pp 8 (London Siemens Brothers and Co, Ltd, 1950 )

The Lamp Vol 32, No 2 Pp 24 (New York Standard Oil Co, 1950 )

Induction Heating Equipment Pp 16 (Watford Wild-Barfield Electric Furnaces, Ltd, 1950 )

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# LEADERSHIP IN SCIENTIFIC RESEARCH

THE series of papers on research and its organisation by Dr Ellice McDonald, director of the Biochemical Research Foundation of the Franklin Institute, originally published in the *Journal* of the Institute, have recently been re-issued under that general title, together with an earlier paper on a bonus system in a research organisation, and two more recent papers on biochemical and medical research, one by Dr McDonald and one by Dr W A Mosher* Covering the choice of research projects, co-operation in research, the direction of research and the choice of workers in research, these papers make a contribution to the literature on the administration and organisation of research, which is the more useful for being drawn from the author's personal experience and quite independent of other current writing in this field

In this brochure Dr McDonald discusses first the changing face of research, and, after commenting that the influence of the research worker on the community is indirect rather than direct, emphasizes that the changes in recent years are due first, to the annihilation of distance, then to the increased scale of operations and, third, to the increased use of power The improvement in rapidity and ease of communication due to the first factor has accelerated the progress of research to an extraordinary degree, while the increased scale of operations has not only encouraged the extension of team-work and of large co-ordinated groups, but has also had its effect on the exchange of information The increased use of power has had its effect chiefly in the large numbers of instruments of precision which have been devised to extend the research worker's range of observation

Dr McDonald argues that the influence of these changes has been most marked in the field of development rather than in that of discovery and research, and he questions whether a planned and completely co-ordinated research programme on a national scale would offer any advantage over independent research activity Discoveries are made by individuals - men and women —and if the free spirit of research is hampered, vision is impaired A planned research tends to concentration in much detail in a few directions, and accordingly, he argues, the chance of hitting the correct solution is less

The chief stress, however, is laid by Dr McDonald on the creative aspect of research and the need for a sympathetic understanding of the research instinct and for untrammelled development of its creative genius This, he urges, is a main factor to be taken into account in choosing research projects The proper choice of research topics, he rightly insists, is the vital factor determining success in research, he defines research projects as experiments directed by the disciplined imagination of a group of individuals of varied mental outlook and diverse training, who are able to transcend the results obtained by the isolated scientific worker, save for the exceptional genius Commonplace qualities, well trained, well proportioned and consistently well displayed, will in organised groups, he maintains, give consistently better success than any individual effort

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* Research and its Organization By Dr Ellice McDonald Pp 96 (Newark, Del Biochemical Research Foundation, 1950 )

The dangers and limitations in the planning and organisation of research are clearly well understood by Dr McDonald, in this connexion his thought seems to run on similar lines to that of Dr E F Caldin, in his recent book, "The Power and Limits of Science" He writes wisely on the postulates to be considered in selecting a research project—and no less in abandoning it—and here again the effect on the staff concerned is uppermost in his mind While recognizing that many important discoveries have been made by accident, he points out that by far the greater number have been made by design, and to his mind the vital task appears to be so to present accumulated and recorded experience to the next generation of research workers that they live in an atmosphere of intellectual stimulation and are inspired to imaginative activity

The very wealth of that experience, however, enforces the need for co-operation in research as in other fields Coupled with the vast increase in the complexity, range and expensiveness of the tools available for research, it has made organisation imperative if the size of operations is to match the new opportunities Dr McDonald recognizes that we are only now discovering the art of working together, and he defines the art of good management as the creation of an organisation which will develop to its highest point the initiative of individuals, consistent with an orderly progression and cohesiveness of purpose The purpose of management and of the collective intelligence, experience and imagination (which imply direction to a given scientific task in research) is likewise to expand the power of each individual worker to be useful, and in this connexion he has in mind particularly the facilitation of co-operation and the interchange of experience between different specialists and across the frontiers of different disciplines Many gaps in the uneven front of research to-day, he reminds us, are represented by unexplored fields which lie between the activities of two or more branches of science These gaps can only be filled in by the interchange of ideas from day to day and over a long period of time, because it is difficult for men of science in different fields to learn the *patois* which each speaks A large research organisation is one means by which that difficulty can be overcome, and when due regard is had to the inherent weaknesses of such an organisation to which Dr McDonald directs attention, the risk of it cramping originality of thought or repressing the flair for discovery is small

Under present conditions, a certain amount of organisation in research is inevitable The essential task is how to minimize its weaknesses and drawbacks, and much in the first place depends on the manner in which the direction of research is exercised, and especially on the director of research himself Dr McDonald's ideas on this point are clear and incisive He has no delusions or exaggerated ideas on the part the director or research manager has to play It is an administrative task calling for someone who, while sufficient of a man of science to understand the outlook of the research worker, is prepared to set on one side any personal interest in research and to take upon his shoulders the bother of the details inherent in an organisation, so that the research workers themselves may be relieved and free to concentrate their energy on the prosecution of their investigations

Such a task calls for all the qualities of leadership in the full sense of its meaning—ability to understand and to handle men, sensitiveness to the atmosphere in which research is most effective and creative, and unflagging zeal to secure and maintain the appropriate atmosphere as well as the mechanical and intellectual tools required A director of research to-day is required, too, to take account of the outlook and thought of scientific workers of diverse character and training if he is to weld them into a successful team The planning of resources in men and women, as well as in material equipment, must figure in successful strategy

Much here will, as Dr McDonald points out, depend on the wise and careful choice of workers, though besides choosing the best it may also be necessary to get rid of those who fall short of the standard No list of qualities– judgment, common sense, modesty, originality, precision, and an unquenchable curiosity are all indicated by Dr McDonald—can replace the capacity to estimate men and their ability, though experience has a valuable part to play In the paper in which he discusses the selection of research workers and the qualities they should possess, Dr McDonald is not completely happy, and in one passage he lapses into a gibe at the amateur He admits the difficulty of recognizing genius, but in claiming that the lone research worker has a span of only three years in which his ideas are prolific, he seems unduly pessimistic He suggests that in an appropriate organisation the stimulating contact with other men of science and other fields of work can prolong the creative life of the individual If, as Prof C J Renier wrote in his recent book, "imagination is nothing but the mobilization of the contents of our memory", there may be something in this view Much will still depend, however, on personal qualities or characteristics if the effective group co-operation and stimulus are to be secured With the exceptional worker - and it is the man or woman with outstanding ability in research that Dr McDonald appears to be considering—this cannot be taken for granted He recognizes indeed that some seem to find impossible the give and take which is required in group research, and there are others who will require educating in this respect before they learn that they, as well as the group, profit from the interchange of ideas and from contact with other branches of science Some few, indeed, will have no place in the modern scheme of research

In these highly suggestive papers, Dr McDonald has both emphasized some of the most important factors upon which success in research depends and has also indicated some of the directions in which still further knowledge is required We are still far from understanding fully the conditions for the stimulation of creative work in scientific research, particularly that concerned with several disciplines or branches of science

# THE SEARCH FOR MAN'S ANCESTRY

### Finding the Missing Link

By Dr R Broom Pp vi + 104 (London Watts and Co , Ltd , 1950 ) 6s net

DR ROBERT BROOM's wonderful discoveries of the remains of primates in the South African cave-deposits during the past fifteen years, following his most valuable finds of fossil Mammalia and Reptilia, have commanded the admiration and gratitude of the scientific world Now, for the instruction of the non-specialist reader, he provides an entertaining account, in racy and often extravagant language of his efforts to discover the connecting link (as Huxley and Darwin termed it) between ape and man Modesty doubtless caused him to refrain from entitling his little book "Finding some Missing Links"

The volume opens with a review of the history of discoveries of ancient or supposedly ancient human remains, the provenance of which in some cases is doubtful Next, the story of the remarkable finds in China and Java, brought up to date, serves as a fitting introduction to his fascinating description of the treasures he has himself unearthed at the Sterkfontein, Kromdraai and Swartkrans caves, and of other discoveries at Taungs and Makapan, until so recently as 1949 The chief value of the book lies in this first-hand narration of his vigorous, persistent and successful labours In the concluding chapters he discusses the affinities of the ape-men (as he terms them grouped as the Australopithecines, after *Australopithecus africanus* Dart from Taungs) that he and Prof R A Dart have found, and he includes some animadversions on man's evolution and his place among the primates

Although the author has been publishing his scientific work for more than half a century, he retains much of the energy, as well as some of the impatience, of youth Many of his remarks about his contemporaries in the fields of anatomy, archæology and geology are deplorable such can be ignored except in those cases where the layman is likely to be misled as to the facts Contemptuous of the cautious attitude of many leading authorities, he scorns the "suspense account" We must not forget, though, that the story of man's ancestry has such a universal appeal that more than ordinary caution is necessary when we come to present evidence for missing links Dr Broom will not have forgotten that the path of progress in the study of primitive man is strewn with discarded but monitory remains like those of Galley Hill man, Ipswich man and Oldoway man, to mention only a few , that *Ecanthropus*, 'The First Englishman', now appears unhappily named , and that *Pithecanthropus*, the 'missing link' of the headlines of sixty years ago, has been deposed from his crucial position in the geological time-scale and deprived of any anatomical claim to be the ancestor of modern man Small wonder if the pendulum should occasionally swing too far the other way Some such recollections as these will be in the mind of the critical reader who peruses this small volume

Although there is some difference of opinion about the affinities of the Australopithecines, Dr Broom's conviction that they are allied to man rather than to the apes is shared by certain other authorities (see *Nature*, November 4, p 758) The names he may attach to his ape-men (like *Paranthropus* and *Plesianthropus*) matter less at the moment than his conjectures about their geological age and his observations on the finds elsewhere of what were claimed to be the remains of very early man In support of his belief in the great antiquity of the ape-men, for example, he asserts that "We know that man of some sort lived in Upper Pliocene", and then refers to the records of *Homo sapiens* from ancient deposits in Kenya Here he is on unsafe ground, for his statement that Kanjera man belongs to the "fairly early Pleistocene" is in conflict with the evidence Even if the fragments of the Kanjera skulls were indigenous to the deposit on or in which they were found, the fauna contained in the oldest beds in the district indicated an age no greater than late Middle Pleistocene, and the stratigraphical relationships suggested that the skull-bearing deposit belonged to a younger series—possibly much younger[1]. Other statements made in connexion with the Kanam and Kanjera finds are not in accord with the facts After declaring that he has looked very carefully into the history of these East African discoveries, he expresses his whole-hearted belief in them and his conviction that the provenance of the remains is not in doubt In view of the weight that might be attached to his opinion on this matter, we would remark that his investigations do not appear to have been sufficiently thorough to enable him to realize that the "critic" (whose report[2] is quoted as an example of pre-existent bias) had to insist, in the face of opposition, that systematic excavations (unfortunately not undertaken at the time of the discovery) should be carried out at the supposed site of the Kanam mandible in the hope that further discoveries would relieve him of the necessity of placing it in a "suspense account" Moreover, apart from the difficulty that arose from the failure to mark the site so that it could be identified, the geological features of the deposits thereabouts were such that it was not at all certain that the parent-bed of the mandible (a decayed and abraded specimen obtained at the surface by a native boy) could be determined positively In fact, the fragment could have been younger than, or of the same age as, or older than, the bed from the surface layer of which it came

These East African remains provide, then, no evidence in support of the view that the Australopithecines are pre-Pleistocene Nor does the fact that the latter are accompanied by genera of mammals now extinct in South Africa necessarily prove great antiquity, although further palæontological work may in time assist in dating the beds There remains the evidence of superposition and petrology (and, dependent on the latter, that of past climatic and physiographical changes) It would have been interesting to know what steps Dr Broom has taken to investigate the geology of the succession of and in the various cave-deposits, and why he accepted the surprising statement about Sterkfontein that "there was no stratigraphy whatever at the place where I was working" Meanwhile, it is satisfactory to learn from other sources that the Australopithecine breccia in the Makapan area certainly antedates deposits containing the South African hand-axe industry of Middle Pleistocene age The existence of still older, pebble-tool, etc , industries is well known , but the relationship that these, assigned to the Lower Pleistocene, bear to the bone-breccias has not yet been established Since no implements have been found in association with the Australopithecines, it is not unreasonable to infer that these primates were too primitive to have been tool-makers, and therefore that they lived either in very early Pleistocene or in Pliocene times , but such deductions go no farther than inference If the Australopithecines were ancestral to modern man (that is, missing links *sensu stricto*) and belonged to the early Pleistocene, and if the men who made the hand-axes were of *sapiens*-type (as the occurrence of the Swanscombe skull suggests), we are faced by a picture of almost incredibly rapid evolution If, however, the Australopithecines all date from the Pliocene, as some authorities are inclined to think, our credulity is less severely strained, but we still cannot ignore the possibility that they are links in the anatomical sense only, that is, specialized or aberrant types like *Sinanthropus*, *Eoanthropus*, or Neanderthal man, rather than 'geological' links in the direct chain to sapient man If they are all Pliocene and ancestral, we are left with an unbridged gap from Pliocene to late Middle Pleistocene, during which much could have happened. Dr Broom has abandoned his earlier view that they were all Pleistocene, and now offers tentatively the succession Taungs deposits ("say 2,000,000 years old"), Sterkfontein breccia ("say 1,200,000 years"), both supposedly Pliocene, and Kromdraai cave-deposits ("not improbably 200,000 or 300,000 years later than the Sterkfontein"), of Lower Pleistocene age, which would cover part of the gap but would raise again the problem of rapid evolution Incidentally, it must be remembered that these figures and others in the book are no more than guesswork, and the preliminary word of caution about them may be overlooked or forgotten by the reader entranced by their repetition We often tend to lose sight of the fact that measured chronology takes us back no more than 20,000 (or possibly 30,000) years , beyond that, all is speculation until the radioactive mineral time-scale comes into operation many million years earlier Extrapolation based on rates of sedimentation, weathering and erosion, or on solar radiation—all controversial subjects—suggests that the Pleistocene may have begun about 500,000 or possibly 1,000,000 years ago, maybe more, maybe less

The interesting conspectus with which the author concludes his volume, like the discussion in Prof Le Gros Clark's admirable little guide on the primates recently published by the British (Natural History) Museum[3], makes us reflect on the present somewhat curious state of our knowledge of man's antiquity For the time being, it is necessary to assume that, in different parts of the world, the boundary drawn between the Pliocene and the Pleistocene, as well as the stages, Upper, Middle and Lower, into which the Pleistocene has been divided (frequently on palæontological evidence), are severally contemporaneous Then we find that, until the evolutionary burst of *Homo sapiens* occurred in late Pleistocene (Aurignacian) times, when he revealed himself as a highly developed tool-maker and artist not without a religious sense, the only reasonably authentic skeletal record of his existence is provided by the portion of a skull from Swanscombe, Kent, believed to be of late Middle Pleistocene age, that is, about 150,000 years older if we adopt a length of 600,000 years for the whole Period. Broadly, recent analysis in which palæontological evidence plays the most important part[4] indicates that the primitive Pekin *Sinanthropus* was apparently contemporaneous with him, and the Java "*Pithecanthropus*" but little more ancient (early Middle Pleistocene) Also approximately contemporaneous was the Piltdown *Eoanthropus*, recently relegated to the late Middle Pleistocene Yet, implement-making was a well-developed art by Middle Pleistocene times, and tools of undisputed workmanship are found in earlier, sometimes much earlier, deposits (possibly Lower Pleistocene), although no skeletal human remains have been seen in association with them And now, into one or more of the earlier chapters of the story, if not into the earliest, the Australopithecines must be introduced Deprived of hoped-for assistance from the more dubio[illegible] records referred to above, Swanscombe man, about whom we actually know very little, seems at present to carry an excessively heavy burden of responsibility in the matter of the antiquity of our sapient stock

Discoveries outside South Africa thus afford no help at the moment in placing the Australopithecines in the geological time-scale, or in assessing their claim to be missing links All the more urgent, therefore, is the need for intensive stratigraphical study of the deposits in and near the caves, to be aided in due course perhaps by modern geochemical methods for age-determinations, some born of recent isotope research The important work of Prof C van Reit Lowe and his collaborators in South Africa encourages the hope that light will eventually be thrown on this outstanding problem in the borderland of geology and archæology P G H BOSWELL

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[1] See, for example, Kent, P E , *Geol Mag* , **79,** 117 (1942)

[2] *Nature* **135,** 371 (1935)

[3] See *Nature*, **166,** 216 (1950)

[4] Movius, jun , H L , Peabody Mus Papers, Harvard Univ , **19,** 3 (1944)

## FUNDAMENTALS OF PLANT PATHOLOGY

### Principles of Plant Infection

A Text-Book of General Plant Pathology for Biologists, Agriculturists, Foresters and Plant Breeders By Prof Ernst Gaumann Authorized English edition by Prof William B Brierley Pp xvi + 543 (London Crosby Lockwood and Son, Ltd , 1950 ) 63*s* net

PROF ERNST GAUMANN's "Pflanzliche Infektionslehre", which first appeared in 1946, is a notable contribution to plant pathological science inasmuch as it is the most substantial attempt so far made to bring the manifold details of research into one large picture In the words of Prof W B Brierley, who is responsible for the English edition, "it develops a consistent body of theory which correlates the facts into a logical and explanatory system" From time to time, it is true, the progress made in certain limited fields has been critically assessed, as in many admirable papers in the *Botanical Review* , but this book is something very much greater

Not merely does it bring together and arrange an astonishing mass of data—for which alone workers in the subject will continue for many years to be deeply indebted to Prof Gaumann—but also it is abundantly interwoven with original interpretations (always to be expected from this author) and unusual points of view These also, as the editor points out, will prove "a mine of argument and controversy, and a source of endless discussion and questioning-- which is what a book of this kind should be"

Of the translation, little need be said other than that it is very good indeed The original drafts were made by a group of assistants, and the whole was afterwards revised and 'homogenized' by Prof (and Mrs ) Brierley This they have done so well that there is no evidence of its mosaic nature, and the text is singularly free of those rawnesses which tend to crop up in translated versions There are occasional misprints, of which the outstanding one is "*sensu stricta*" (headings of all odd-numbered pages from p 281 to p 351)

Apart from a short account of disease control (which is almost in the nature of a postscript) the subject-matter is arranged in five long chapters, dealing with the mechanism of infection, transmission of disease, epidemiology, "disease proneness" of the host, physiological and morphological effects of disease, etc The arrangement is logical, but it does, in fact, lead to a certain amount of repetition Each topic is split up, again and again, so that the table of contents comes to wear rather a formidable aspect, and there are still further subdivisions in the text One feels that the book is over-sectionalized—that distinctions are drawn which are not based on evidence of substance and that there are compartments which as yet are devoid of *bona fide* occupants

This leads to the controversial points which Prof Brierley mentions They are here in abundance, in looking through the text, I have noted more than a hundred such places—places where I would query either the value of some data or the conclusion drawn, or the use of a word, or suchlike The language is often teleological, but we are told in the preface that it is not to be so considered One rather wonders then how it is to be considered It is obviously impossible to set out these criticisms here, but they will occur to any student who reads carefully

On the matter of terminology, with which this book is heavily loaded, there will no doubt be differences of opinion Prof Gaumann borrows freely from human medicine, and this is in conformity with his marked tendency to bring animal and plant pathology into the same pattern, in some cases rather incongruously Other words are his own invention Many of these, one feels, are superfluous, and their effect is often merely to lengthen the argument and nothing more Prof Gaumann's acute mind revels in fine distinctions, and he adopts or coins the appropriate words It is almost with pleasure, therefore, that one finds that even he occasionally nods Thus, in the first sentence of the book, the word "infection" is applied to the first of the five phases or stages of an infectious disease, on p 36 it has come to cover the first two stages, and in the title of the book it is clearly intended to cover all five

There remains the question of what kind of student will read his Gaumann with profit The title-page speaks of it as a text-book for agriculturists, foresters (and others) I have no wish to disparage these people when I say that they would make little headway with it or get much of the specific information which would help them in their type of problem The book is essentially for the plant pathological specialist, and for the more academically minded one at that It has its uneven patches, and parts of it could be pruned away with advantage Nevertheless, in its general scope and execution, it is a brilliant piece of work, and one which will undoubtedly stimulate and guide the plant pathological research of the future

W Brown

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# FUNDAMENTALS OF ADVANCED ORGANIC CHEMISTRY

### Advanced Organic Chemistry

By Prof G W Wheland Second edition Pp xi+799 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949) 64*s* net

At the outset of his postgraduate training in organic chemistry, many a serious student must feel a desire to retrace a portion of his previous path as an undergraduate in order to make a more determined effort to apprehend the underlying principles of the science which, owing to the congested curriculum of degree courses, he has necessarily considered mainly from the descriptive point of view He would find the requirements of this undertaking provided in a most interesting and comprehensive manner by Prof G W Wheland's thought-provoking book which now appears in its second edition Rather than being an elaboration of facts, this volume attempts to place the simpler chemistry already learnt on a sound theoretical basis The treatment is non-mathematical and "the primary guiding and unifying principle is the structural theory in its broadest sense"

The first half of the book is devoted to a clear and critical review of the structural theory The first chapters describe the forces binding atoms into molecules, the loose forces between molecules and the forces binding molecules into addition compounds, for example, the hydrogen bond The spatial disposition of atoms in organic molecules is then discussed at length in five interesting chapters to form what must be one of the best summaries of stereochemistry in the English language Discussions of steric strain and steric hindrance brought about by the interaction of atoms, and of the modification of 'classical' structures of molecules by resonance, form the subjects of the next two chapters Excellent sections on molecular rearrangements (130 pages) and tautomerism (65 pages) then follow, and the book closes with a chapter on free radicals

Throughout, the text is liberally supported with references to the original literature, including the most recent publications In places, the emphasis on structural considerations has resulted in other physical evidence being overlooked For example, in the account of the Walden inversion only one paragraph is devoted to a discussion of the mechanism of the phenomenon, the kinetic evidence for this being largely lost sight of This, however, is but a minor criticism of an excellent book which can be unreservedly recommended to chemists for developing their critical outlook and increasing their real understanding of a fascinating branch of natural knowledge

## Principles of Organic Chemistry

By Prof John Leo Abernethy Pp viii+317. (Philadelphia and London W B Saunders Co, 1949) 20*s*

THIS is an elementary text-book designed to cover a first-year course of some ninety lectures on organic chemistry On the whole, the treatment is orthodox, although the placing of emphasis is sometimes unusual, as a result, perhaps, of the author's "careful selection of topics, eliminating much of the material that tends to make organic text-books encyclopedic sources of information, discouraging to the beginning student"

The book begins with a brief exposition of the Lewis electronic theory and then deals with aliphatic compounds with reference to their functional groups Tautomerism is briefly mentioned, but in this connexion neither acetoacetic ester nor malonic ester is described, in spite of their theoretical interest and their practical utility The structure of benzene is presented from the resonance point of view, and the problem of aromatic substitution explained on the principle of alternating polarity in a conjugated system Aromatic compounds are dealt with in twenty pages and heterocyclic compounds in eight, but proteins, dyestuffs and oxidation-reduction reactions receive special treatment

Nevertheless, the author achieves much in packing the bare, sometimes very bare, bones of organic chemistry into so small a compass The early emphasis on nomenclature and formulation—so often a stumbling block to the beginner—and the useful problems collected at the end of each chapter are welcome features The book is well produced and notably free from misprints, but on pp 152–3 *tert*-pentyl occurs no fewer than seven times when *sec*-butyl is clearly intended

## Electronic Interpretations of Organic Chemistry

By Dr A Edward Remick Second edition Pp vii+600 (New York John Wiley and Sons, Inc, London Chapman and Hall, Ltd, 1949) 48*s* net

IN this second edition of his book, Prof A E Remick has enhanced the value of the well-known first edition by a revision of the whole text and the addition of a new chapter entitled "Some Contributions from the Field of Stereochemistry" This has been achieved, while keeping the book within a reasonable size (and price), by severely abridging the historical introduction and omitting some appendixes

The opening sections in general follow the historical development of electronic organic chemistry Early theories of the reactivity of molecules are discussed, together with their translation into terms of electron shift and electron availability, by the application of the electronic theory of valency enunciated by Lewis An account of the modern theory of this electron shift is then given and the theory shown to be firmly based by the presentation of supporting evidence, this occupies the remainder of the first half of the book The principles are then applied to electron-sharing reactions involving heterolytic bond fission, aromatic nitration and sulphonation, the extensive work on the substitution reactions of alkyl halides, ester hydrolysis, elimination reactions, etc, and to electron-pairing reactions involving homolytic formation and fission of bonds Finally, the bearing of the theory on some branches of electrochemistry is discussed

This book provides one of the best surveys of the uses of the electronic theory in organic chemistry—a field of speculation in which different schools have a tendency to use their own terminology and not infrequently disagree on interpretation of results

## Physics Tells Why

An Explanation of some Common Physical Phenomena By Overton Luhr Pp ix+387 (London George Allen and Unwin, Ltd, 1947) 16*s* net

IN this book Prof O Luhr, who unfortunately died before publication, set out to provide an interesting and a popular study for the layman without the use of the mathematics which must of necessity accompany a serious study of formal physics His aim is to explain in a simple fashion many of the common physical phenomena in relation to everyday life, and it must be readily agreed that he has produced a very readable and interesting book covering many branches of physics

With the aid of simple and original diagrams, the author discusses both natural and man-made physical phenomena in language that a young student and the layman can easily follow, and into the 359 pages he has crowded an amazing amount of information A further interesting feature of this well-written book is the group of short questions and answers at the end, the keen reader is able to test how much knowledge he has assimilated

Since the time when the book was first published in 1943, two new chapters have been included dealing with more recent developments such as radar, jet-propelled aircraft, atomic energy, etc, and these conform in style to the general character of the rest of the book

## The Honeybee

An Introduction to her Sense-Physiology and Behaviour By C G Butler Pp viii+140+6 plates (Oxford Clarendon Press, London Oxford University Press, 1949) 10*s* 6*d* net

DR C G BUTLER has written a comprehensive survey of what is known of the senses and behaviour of the honey bee, especially the behaviour, about which much has been learned in recent years The knowledge is hard to come by without the help of such a guide as this A better understanding of the habits, abilities and limitations of the honey bee in the collection and utilization of nectar, pollen and water is of the first importance to the practical bee-keeper, but the story will be welcomed by all interested in the insect world, whether as naturalists, physiologists or biologists

Any such study must be coloured somewhat by the predilections of the author, so naturally the best work is found in those fields in which the author and his colleagues have been active Anyone will have trouble, in the present state of knowledge, in interpreting what is known of vision in insects, but I am unable to accept either that the bee sees grey at the red end of the spectrum or that it is materially short-sighted Some figures will require reconsideration, compare, for example, the data on pollen loads given on pp 79 and 131 One dare not look twice at the bee illustrated on the publishers' dust cover, but it would be wrong to cavil at a few details in a work which must have involved great labour, is generally well done, and should satisfy a wide demand

E B WEDMORE

# APE OR MAN?

By Dr. R. BROOM, F R.S., and J. T. ROBINSON
Transvaal Museum, Pretoria

IN 1925, Prof Dart announced the discovery of a new type of higher primate that seemed to be somewhat intermediate between ape and man This was the skull of the Taungs child which he called *Australopithecus africanus* For some years there was considerable dispute between those of us who regarded the little skull as that of a being closely allied to the ancestor of man, and those who considered it only a variety of ape, allied to the chimpanzee, which by parallelism had come to resemble man in many characters

Since 1936 we have made a large number of new discoveries, and this group of higher primates is now known by many skulls and skeletal remains of adults of a considerable variety of forms which we think should be placed in different genera and species

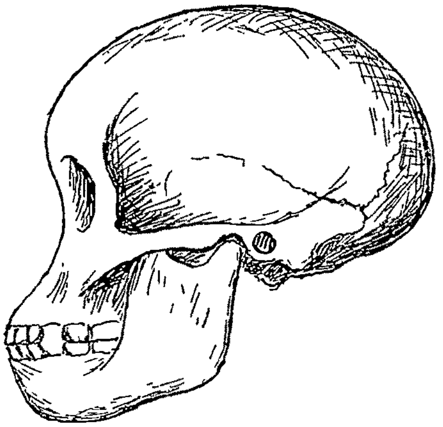

Fig 1 Attempted restoration of seven-year-old male *Paranthropus crassidens* (⅓ natural size) The skull is almost complete, but the top is much crushed down on the base The mandible is drawn from the jaw of another child As restored the brain would be more than 700 c c

In the past two years we have discovered a number of nearly complete skulls which give us a new picture of the origin of man When the only known skulls of our so-called 'ape-men' had brains of between 450 and 650 c c , those who said they were only apes and had no close relationship to man seemed to have some case But now that we have skulls with brains of 750, 800 and possibly 1,000 c c., we seem to be dealing with beings that have some claim to be called human

Recently we have found five skulls with fair-sized brains One is a child skull with a brain of perhaps 600 c c , and one that of a child with a brain of about 700 or 750 c c Then we have two nearly complete female skulls with brain cases which we estimate at about 800 or 850 c c Each skull lacks the occiput, but is otherwise nearly complete although somewhat crushed It will take some time to reconstruct an uncrushed skull , but we seem very safe in considering that it had a brain of more than 800 c c

In structure the skulls are very interesting The face is flat and broad Above the eyes is a transverse supraorbital ridge , but it is more slender than in Pekin man, and a little like that of *Pithecanthropus* There is practically no brow The temporal muscles must have been relatively very large, and they passed up to the top of the skull as in male gorillas, and were separated by a bony sagittal crest rising about 12 mm above the general surface of the skull The ear region and the glenoid are almost typically human, and there is a large mastoid process and well-marked mastoid notch

The palate and teeth are essentially human, and the incisors and canines would be accepted by most dentists as human teeth

We have a perfect female mandible with all the teeth in perfect condition and a number of other jaws in fairly good condition One striking feature is that all the jaws have some indication of a chin, and one has a typical human chin with a well-marked mental prominence If we did not have the whole symphysis, which is very thick, and the molar teeth, which are certainly those of *Paranthropus*, we might suspect this jaw to be that of a *Homo*

Then we have a very fine pelvis It has a large, wide ilium, practically human and not at all ape-like, with an ischium that is not human and which also differs considerably from that of the Sterkfontein ape-man *Plesianthropus*

When Dart described the Taungs ape-man the large majority of men of science in the northern hemisphere were of opinion that it was an anthropoid ape allied to the chimpanzee and gorilla One went so far as to call it a "dwarf gorilla" But soon one or two came to the conclusion that, if an anthropoid ape, it is the one known that is nearest to man But most anatomists apparently took little interest in the skull

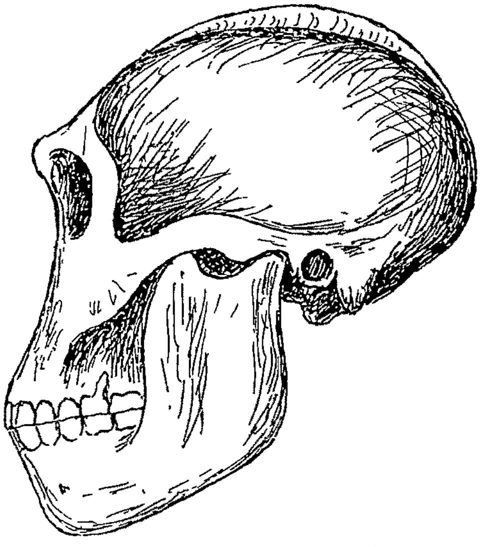

Fig 2 Restoration of skull of female *Paranthropus crassidens* (⅓ natural size) The skull is satisfactorily known except the occiput, but is considerably crushed The mandible is perfect, but is that of another individual As restored the brain would be more than 800 c c

In 1936 the senior author started a search for an adult skull, as the child skull did not seem to be understood , and a fairly good skull of an adult allied to the Taungs child was found on August 17 at Sterkfontein This was made the type of *Plesianthropus transvaalensis* Two years later another type of skull was found at Kromdraai, and named *Paranthropus robustus* Some anatomists in Britain and America assumed it as probable that the two adult skulls were merely adults of the Taungs species Then in November 1948 another new type was discovered at Swartkrans and called *Paranthropus crassidens* Even now there are, we believe, many who consider that all our types are at most only species of *Australopithecus*, and a few still hold that they are all anthropoid apes A considerable number of men of science from America and Europe have visited South Africa to examine our specimens, and we think all who have taken this trouble have gone back convinced that at least we have the remains of beings that were much more human in structure than any known living or fossil apes

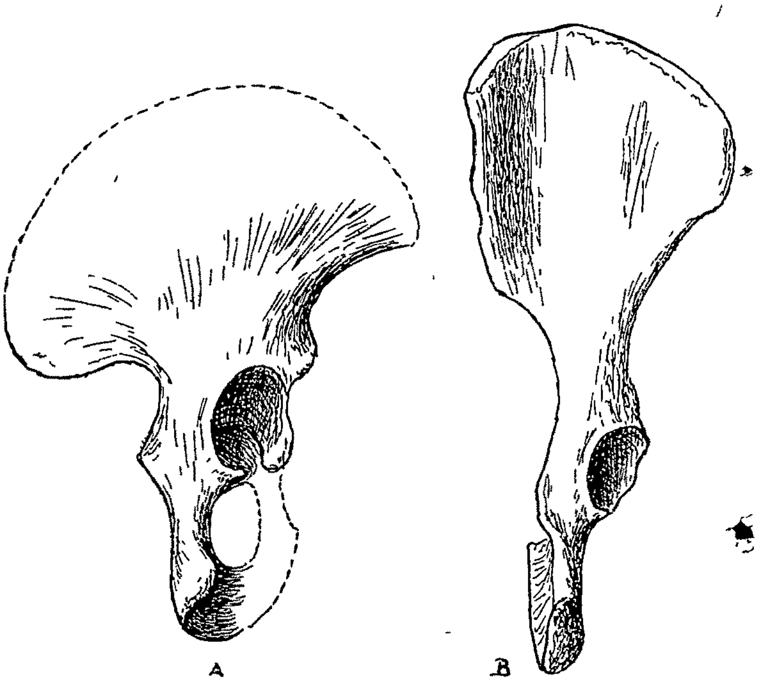

Fig 4 (*A*) Right pelvic bones of Swartkrans ape-man , (*B*) right pelvic bones of old female orang Both one third natural size, and similarly orientated in plane of ilium

Opinions still differ considerably Some have argued that all our ape-men are true human beings Some—a very few, we believe—consider they are anthropoid apes Probably most prefer to wait, and call them ape-men

*Plesianthropus* has a female with a brain of about 500 c c , and this seems to us a brain scarcely large enough to entitle it to human status—though it may be in the human line

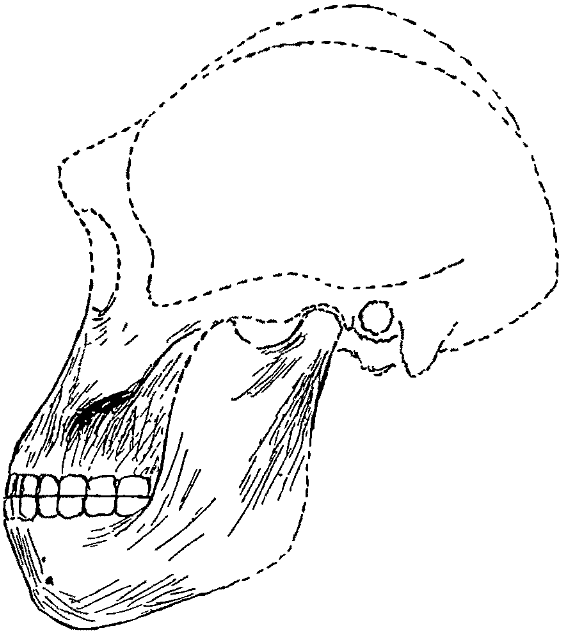

Fig 3 Restoration of skull of male Swartkrans ape-man *Paranthropus crassidens* (⅓ natural size) Only lower jaw and face are known As restored the brain would be about 1,000 c c , and thus well within the human range

*Paranthropus crassidens* we now know fairly well It has a brain of about 800–850 c c in the female, and perhaps more than 1,000 c c in the male Even in the female it has a large bony sagittal crest It has milk teeth differing so much from those of *Plesianthropus* and *Australopithecus* as to seem to confirm the correctness of placing it in a distinct genus Its pelvis is also different in important details from those of both *Plesianthropus* and man

The question now arises—must *Paranthropus crassidens*, with a brain well in the human range, be called an 'early man' ? It is clearly an ape-man that has by a mutation developed a large brain—possibly in structure a human brain, and one might argue that it is an early type of man—perhaps the ancestor of man

Again, the teeth seem to solve our problem *Australopithecus* and *Plesianthropus* have remarkable milk pre-molar teeth Man has exactly the same type But *Paranthropus* has a more primitive type, so that it seems more probable that man (*Homo*) has evolved from a *Plesianthropus*-like type than from a *Paranthropus*

Possibly we are correct in assuming that there lived in South Africa a million or perhaps two million years ago a family of higher primates, not closely related to the living anthropoids, but perhaps evolved from a very early anthropoid or even a pre-anthropoid by a different line, that this line early became bipedal and soon used the hands for tools and weapons, and that one branch of this family, about Upper Pliocene times, gave rise to man There is no doubt the family varied greatly, and the safest conclusion to which we can at present come is that of the writer in *The Times* of July 28, who says "It seems clear that the *Australopithecinæ* as revealed up to now were 'almost man , and their presence in the Transvaal a million years ago strongly reinforces the possibility that something which we should recognize as man was first evolved in Africa"

# AUTOMATIC CONTROL SYSTEMS

By Prof A. TUSTIN

University of Birmingham

AUTOMATIC control was the subject of a paper in Section G (Engineering) of the British Association at this year's meeting at Birmingham It has since been the theme of a very well-attended conference at the University of Birmingham, and next year (July 16–21) it is to be the topic of a conference which is being arranged by the Department of Scientific and Industrial Research The interest in the subject is world-wide, and is not confined to professional engineers

This spate of interest and activity, like most spring tides, is due to a conjunction of causes War-time developments such as automatic aircraft tracking, the guiding of flying-bombs, automatic gun-laying and many others led to a clearer understanding of what was possible, and suggested many industrial applications of the same principles

New possibilities have been opened up by progress in developments of thermionic amplifiers, and the theory of amplifiers and filters, and by the appearance during recent years of a series of new forms of amplifier for larger powers These include many varieties of rotary amplifier, such as the 'metadyne', the 'amplidyne', the 'rototrol' and the 'magnavolt' There is also the magnetic amplifier—a development of the saturable reactor—and various controlled gas-discharge devices, such as the 'thyratron' and the grid-controlled rectifier

A good deal of the present interest in automatic control arises from the fact that specialists in every branch of industry are asking whether some particular process can be done better under automatic control than under human control They sometimes ask whether automatic control may make possible a precision and speed which no human operator could approach

The recent developments in automatic control have been of interest to many scientific workers outside the field of engineering because of certain very striking analogies, and in a limited sense identity of principle, between the engineers' 'closed sequence controls' and a variety of phenomena in physiology, neurology, biology and economics which are somewhat analogous to 'situations of control', and which are characterized by the occurrence of oscillatory variations or instability

The concept which has clarified the engineers' approach to control problems, and which is equally applicable to this wide range of phenomena in other fields, is that of a 'closed sequence of dependence' In seeking to describe the behaviour of any system, one may characterize its state by the values of a number of quantities or variables The equations describing the system state how the value of each variable is determined by one or more of the other variables It is very illuminating to represent the 'scheme of dependence' diagrammatically as in Fig 1 Here various interdependent quantities in a system are represented by the circles, and a line with an arrow, from *B* to *C*, for example, means that *C* is dependent on *B*, and alongside this arrow may be indicated (by the equation or an equivalent operational symbol) how the variation of the quantities are related Such a diagram is simply a particular way of writing down the set of equations of the system It makes visible a distinction which is of great importance in respect to the behaviour of such systems, namely, the existence or non-existence of any 'closed sequence of dependence', such as the sequence *B–C–D–E–B* in Fig 1

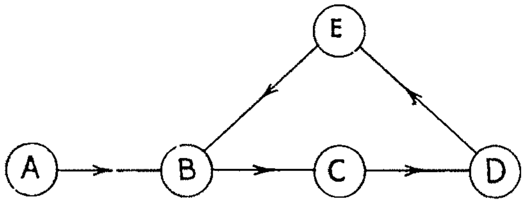

Fig 1 Scheme of dependence with a closed sequence

The significance of this distinction is that systems the scheme of dependence of which includes one or more closed sequences are liable to show various forms of 'self-excitation' If the quantity *B* in Fig 1, on increasing, causes, via the closed sequence, and subject to some time delay, an increase in *B*, then the behaviour of the system may, on certain conditions, be a sustained or cumulative increase in the value *B* A kitten chasing its own tail is a good example of such a closed sequence system We do not know what mathematical function would best describe the dependence of the activation of the kitten on the proximity and velocity of the tail, but the rate of gyration has been observed to rise to a considerable value, no doubt limited on account of the non-linearity of this dependence

If, on the other hand, the response or 'feedback' via the closed sequence is not positive (or cumulative) but suppressive, self-excitation is still possible if this response is delayed in time, but in this case it is oscillatory, at such a frequency that the feedback is delayed in phase by 180°, and so is cumulative at that frequency

Most control and regulating devices have 'schemes of dependence' of the same basic pattern as that given as Fig 1, because they are 'error actuated' systems For example, consider the auto-pilot of an aircraft A device is provided that 'measures' the error $\varepsilon$ of direction of flight from a required angle $\theta_i$ (relative to the axis of a gyro-compass) If the direction of flight is $\theta_0$ then $\varepsilon = \theta_i - \theta_0$ The error $\varepsilon$ is caused to determine the angle of the rudder, which in turn determines the rate of turn of the aircraft, and so determines the variation of $\theta_0$, and the direction of variation is, of course, made corrective The basic 'scheme of dependence' is then as shown in Fig 2

The arrows from $\varepsilon$ to $\theta_r$ and from $\theta_r$ to $\theta_0$ represent respectively the dependence of rudder angle on the error, and the dependence of direction of flight on rudder angle Both these dependences involve time-lags, and the closed loop is suppressive Thus the system is capable of self-oscillation if the response round the closed loop is sufficiently great at the

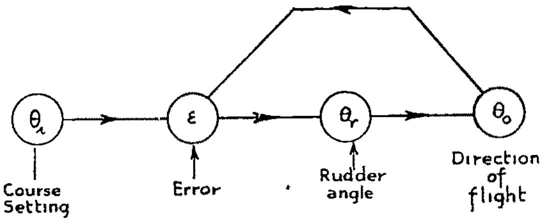

Fig 2 Scheme of dependence for an automatic pilot

frequency at which the phase-lag is 180° This sets a limit to the accuracy of control possible Time-delays in the response of the 'control sequence' are the enemy of accurate control

Present developments in automatic control largely centre around the search for means of amplifying power without undue time-delay The thermionic amplifier is ideal for low-power stages, for its time-delays, in this context, are negligible The high-power stages must, however, provide the required output, and in some applications, such as varying the 'draw' or tension in a steel-rolling mill, hundreds or even thousands of horse-power may be required No means has yet been devised of obtaining continuous control of large powers which is instantly responsive to control signals of small power These time-delays are usually due to storage of energy in the apparatus corresponding with each increase in output, and obviously such energies cannot in practice be built up instantly when some low-power input quantity changes, because such an instantaneous change would imply an infinite source of power To a limited extent these supplementary energies may be supplied from the output or high-power end of the sequence, and this is the basis for the use of 'supplementary feedsback' , but the possibility of such further closed loops introducing new problems of stability will be obvious

The occurrence of such closed sequences of dependence in many fields outside engineering would be expected In the neuro-muscular systems of animals many examples occur Derangement of such systems may produce characteristic oscillatory phenomena, such as tremors, or that periodic variation of breathing-rate known as Cheyne–Stokes respiration. In biology, the oscillations of competing populations may be described in this way In economics, J M Keynes displayed the mechanism of the economic system as that of a closed-loop system, although he did not use this term The principal closed sequence is level of incomes – expectation of profit – rate of investment – level of incomes There is also a sequence of higher periodicity, namely, income – spending – production of consumption goods – income Economists now appear to accept the general implications of this closed-sequence situation, and the implementation of a full-employment policy largely depends on this recognition ; but they appear to find difficulty in discovering, by field-studies or otherwise, the essential data relating to the time-functions involved in these dependences If they could suggest possible forms for these time functions, electronic models could easily be contrived that would simulate the behaviour of an economic system for which they applied

An advantage of recognizing the significance of closed sequences of dependence wherever they occur is that such recognition immediately makes available all the apparatus of analysis that has been built up around the engineer's problems, including the feed-back amplifier Particularly in the case in which the dependences, for some range of variation, are approximately linear, a great wealth of mathematical apparatus exists, which provides the answer to almost all questions likely to be of interest Even when non-linear relations are involved, both useful methods of attack and a few useful general results are available, and in all cases, however complex, there are possibilities of semi-experimental investigation using electronic or other analogues It is to be hoped that teachers of physics, mathematics and engineering will pay more attention to the concept of the closed sequence and its implications, not only because of its already very great importance in many fields of technology, but also because it provides an excellent example of a concept extending over a very wide range of phenomena, and provides a simple approach to many topics in applied mathematics, which is of pedagogic value

There are two aspects of the study of closed-sequence systems which should be specially mentioned, because they are being actively investigated at the present time The first is the application of automatic control in the chemical industry, and the control of chemical processes by measurement of physical quantities that indicate the state of material undergoing continuous processing, and regulation of temperature, flow, pressure and so on in accordance with these measurements This field has its special difficulties because of the very long response-delays involved, and because of non-linearities in the response characteristics A second field of present importance, in relation to defence as well as industrial problems, is the behaviour of control which involves a human operator, that is, manual control This situation involves a closed sequence via the dependence of the action of the operator on the quantities (meter readings or other indications) which he receives As such responses, even of a highly trained operator, involve irreducible time-delays, the possible accuracy of manual control is limited This situation arises, for example, in the control of high-speed aircraft from instruments, or in the laying of a telescope on a moving target There is great interest in the processes by which, in the course of training, well-determined patterns of response are developed, and it may be expected that progress will emerge from such studies both in improvement of training methods and in the improvement of control characteristics

# BRITISH EMPIRE CANCER CAMPAIGN

## ANNUAL REPORT FOR 1949

THE twenty-seventh annual report of the British Empire Cancer Campaign* is a substantial volume of 363 pages, giving an account of the biological, chemical, physical and clinical investigations supported by the funds of the Campaign (including administration and appeals, £212,000 were disposed of in 1949) No single reviewer could adequately deal with all four categories of research , moreover, compression and selection in this article, dictated by limitation of space, will leave many interesting topics unmentioned

The rank growth of some lines of cancer investigation, particularly on the carcinogens and on tumour inhibitors, has rapidly led from discovery to the developmental phase, where a considerable proportion of the publications describe detailed methodical variations of conventional types of experiment Interest has been stimulated by the introduction of modern physico-chemical theory in studying the relation of structure to activity of carcinogens and tumour inhibitors The section of the report dealing with this branch of work is decidedly technical and will probably be beyond the scope of those readers whose physico-chemical education is a thing of the past The explanation for the somewhat esoteric quality of this material is, of course, that the annual report of the Campaign is intended not only to give a general survey of the researches financed by its grants, but also to act as an internal bulletin for its own specialized investigators It might perhaps be pointed out that physics and chemistry are well-developed sciences, whereas oncology has had barely half a century of painfully difficult progress in which to achieve half a dozen major discoveries

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* British Empire Cancer Campaign Twenty-seventh Annual Report covering the Year 1949 Edited by Sir Heneage Ogilvie Pp 363 (11 Grosvenor Crescent, London, W 1 1950 )

In previous reviews of the annual reports (see *Nature*, 159, 527 (1947); 161, 385 (1948), 164, 523 1949)) the writer has indicated the principal lines of investigation and development followed at the present time by the Campaign's centres of research, and has demonstrated that these lines are also pursued by cancer research workers internationally. The chief approaches are carcinogens and carcinogenesis, chemotherapy, the biochemistry of tumour and patient, and sex hormones in cancer, in the sphere of physics, the radioisotopes, the mechanism of the action of radiations and the development of radiotherapeutic technique, and thirdly, investigation of a clinical and pathological type

The Campaign's clinical committee report is a lengthy document of fifty-seven pages, a "detailed statistical analysis of 242 cases of sarcoma of the soft tissues and of 132 cases of sarcoma of bone" It is from this kind of data that generalizations of extraordinary interest emerge, such as, for example, the relation of the patient's social class to cancer of the skin, of the penis, scrotum or cervix, and of the alimentary tract

Radiological advances show a rapidly increasing use of radioisotopes, for example, bromine-82, phosphorus-32, sodium-24, iodine-131, zinc-65, sulphur-35, cobalt-60, potassium-40, radioiridium, radiotantalum and heavy nitrogen Sodium-24 has been employed to irradiate cancers of the bladder by inserting into that organ a bag containing a solution of the radioactive salt, and also for measuring the effect of adrenal corticosteroids on the excretion of sodium from adrenalectomized rats, iodine-131 is used for the treatment of thyroid cancer and of lymphadenoid goitre, cobalt-60 is now considered as a substitute for radium, for it can be manufactured in the atomic pile, a study of the distribution of zinc-65 injected into the system has been undertaken on the grounds that the higher zinc content of some tumours might to some degree realize what has long been the aim of radiotherapists, namely, the exclusive irradiation of the tumour This idea was, naturally, first applied to iodine-131 in the treatment of cancer of the thyroid

Phosphorus-32 as phosphate has been given orally to patients suffering from polycythæmia and chronic myeloid leukæmia, the isotope can be detected in a limb opposite to the injection site in a few seconds, and in thirty minutes the uptake in the extracellular fluids is complete By labelling antigens and antibodies with iodine-131, phosphorus-32 or sulphur-35 introduced into the protein molecule, experiments are being done on the fate of these substances in the body Radiation from potassium-40 shows that "the average dose to human tissue due to $\beta$ and $\alpha$ rays from their potassium content (i e naturally occurring $K^{40}$ isotope) is estimated as approximately $3 6 \times 10^{-5}$ r/day, that is, one third that received in the same time from cosmic radiation at sea level" In experiments on the synthesis of the protein component of nucleoproteins, glycine labelled with heavy nitrogen (nitrogen-15) was injected into irradiated rats, which were then sacrificed and the tissues assayed for nitrogen-15 Radioisotopes as therapeutic agents necessitate certain precautions, for example, if thyroidectomy has to be performed on a patient who has been treated with iodine-131, the instruments, gloves, dressings and towels used during the operation have to be carefully monitored and decontaminated

The brilliant results achieved by antibiotics has naturally raised great hopes that the same successes will attend the search for chemotherapeutic compounds for cancer This urgent pursuit shows no sign of slowing down Certainly, the nitrogen mustards, the sex hormones (natural and artificial) and urethane have given dramatic, albeit temporary, clinical improvement But unfortunately the mustards are violent poisons, and the sex hormones fail after a time because the tissues of the patient learn to adjust themselves to the new hormonic environment

The chemotherapeutic potency of compounds is being investigated in the laboratory by reference to their nucleotoxic and radiomimetic activity and by the arrest of mitosis in chick fibroblasts in tissue culture, by their effect on the growth of broad bean root, by the capacity to inactivate hæmolytic complement and by their combination with proteins to give products with immunologically different characteristics Among the latest anti-cancer drugs are folic acid analogues and other pterins, the ironical circumstance has arisen that anti-pterins are also being used for cancer chemotherapy (that is, analogues of the type of amino-pterins which compete with pterins in the tissue processes) The newer tumour inhibitory substances include some which have been synthetized, bearing in mind the structural formula of colchicine, others are 4-aminouracil and some compounds of the pyrimidine type, certain fractions of wool fat separated by crystallization from different solvents, chromatography and high-vacuum distillation, and, lastly, the alkaloids extracted from ragwort (*Senecio Jacobœa*) (which give an old-world flavour to this catalogue of anti-cancer drugs)

Apart from research and development in the field of radiology, carcinogenesis is probably the most popular theme of investigation The nitrogen mustards have proved to be powerful carcinogens when injected into rats and mice The search for an explanation of carcinogenic action is being carried on via a number of routes, for example, by an examination of the metabolic products from carcinogenic hydrocarbons given to rats and rabbits, and by a comparison between the order of biological activity of a chemical series of carcinogens and the order of their reactivity with perbenzoic acid The idea that parallelisms of this kind (chemical, biochemical or physical) would suggest a mechanism of carcinogenesis underlies a great deal of the experimental and theoretical research in this important branch

The conclusions drawn from Berenblum's highly suggestive and original work on the mechanism of tumour induction have been criticized by Gwynn and Salaman Berenblum's method, very briefly, is to paint a solution of carcinogen (for example, methylcholanthrene) once only on the skin of a mouse When at any time later (a few days up to six months) the same area is painted with a co-carcinogen—croton oil—tumours arise after an interval, independent of the gap between methylcholanthrene painting and the beginning of painting with croton oil Berenblum's interpretation is that painting once with carcinogen suffices irreversibly to mutate a few cells, the great majority of the cells painted returning to normal, when the skin is later treated with co-carcinogen, these mutated cells begin to grow as tumours Carcinogenesis thus is a two-stage process, 'initiation' and 'development' Gwynn and Salaman, using Glucksmann's technique of differential cell counts on small pieces of skin removed at biopsy, find that the whole area of skin reacts to treatment with croton oil by a rapid rise in the resting cell percentage In other words, although after a single painting with methylcholanthrene the skin appears to return to normal, that normality depends on the technique used for its examination However, this criticism does not disprove Berenblum's hypothesis, it suggests the need for support by subsidiary hypotheses, a fate which has overtaken other speculations in cancer research

Industrial cancer is being attacked by a study of bladder cancer in the dyestuffs industry, where β-naphthylamine is known to be a dangerous intermediary in manufacture It is to be hoped that the publicity given by industrial investigation and by experiments on laboratory animals will lead to this amine being generally prohibited in industry Cancer of the hands and arms in engineering where lathe operators become splashed with cutting oils is being investigated by three groups of workers whose aim is to provide information for the Medical Research Council, which will then advise the oil companies on what types of oil can safely be incorporated in cutting oils

Sir Ernest Kennaway's contribution to the report is, as usual, of special interest He has investigated the relation of the hygienic measures laid down by religious practice to (1) the lower incidence of cancer of the cervix in Jewish women (lower, that is, than in non-Jewish women), and (2) the immunity of Jewish men to cancer of the penis

Sir Ernest, in a study of the causes of the great increase in lung cancer in recent years, concludes that a case can be made out for an increasing pollution of the atmosphere and in the smoking habit The conditions of temperature and oxygenation during tobacco smoking do not yield measurable amounts of benzpyrene, and he implies, although he does not state, that the carcinogenic agent might be the minute amount of arsenic in the tobacco which is applied in the insecticidal spraying of the growing crop

Experiments with the same perspective, which could be described as factors in daily life as causes of cancer, have been carried out by Cornelia Hoch-Ligeti, who fed the fiery chillis (*Capsicum frutescens* and *Capsicum annuum*) to rats Twelve out of twenty-one rats showed some neoplastic changes in the liver (multiple cystic cholangiomata, solid adenomata) or adenocarcinomata of the bile duct She states "A decision has not yet been reached as to whether chilli should be considered a specific carcinogen or whether a deficiency in the diet, or a deficiency aggravated by chilli acting as a non-specific irritant, is the cause of the tumours Both in the sequence of events which lead to their development and in certain histological features, these tumours bear a resemblance to the primary hepatic tumours which occur in man in certain parts of Asia and Africa "

Browning, after finding that two carcinogens applied to the tissues of an experimental animal in sub-threshold doses can reinforce each other, says "The possible importance of such a finding has recently been emphasised in the matter of food adulterants It is clearly not sufficient that dyes or other substances used in food should each be present in less than carcinogenic amount The probability of more than one carcinogen being present in a food might constitute a danger as a result of such synergic effect "

The virus problem has attracted much attention in the past year, when Gye, Craigie and associates (at the Imperial Cancer Research Fund) announced that they had obtained evidence that mouse tumours were transmissible by a virus, since mouse sarcoma could be frozen and dried and yet would grow vigorously on grafting into healthy mice The conclusions of Gye *et al* depended entirely upon the premise that freezing and drying kills the cells of [illegible] tumour and liberates the virus Investigators in both centres of the British Empire Cancer Campaign have now shown that such 'evidence' does little more than beg the question and that the drying technique is imperfect, and in one series of experiments, by Lasnitski, growth *in vitro* could still be obtained from the frozen-dried and reconstituted material

# OBITUARIES

## Prof. M. L. Fernald

MERRITT LYNDON FERNALD, who died on September 22, had been for many years the leading student of the flora of eastern North America

He was born at Orono, Maine, on October 5, 1873, and was appointed to the staff of the Gray Herbarium in 1891, taking his degree at Harvard in 1897 He was curator of the Herbarium during 1935–37, and succeeded B L Robinson as director in 1937, retiring at the end of June 1947 From 1915 until 1947 he was Fisher professor of natural history (botany) He was associate editor of *Rhodora*, the journal of the New England Botanical Club, when it was founded in 1899, and was editor-in-chief from 1929 until his death It was in *Rhodora* that he published most of his detailed taxonomic studies

Two of his earliest papers dealt with tropical species of *Pectis* and *Salvia*, but he soon turned to his real bent—the geography and taxonomy of the flora of eastern North America Most happily he combined the two interests and made each serve the other He was a natural taxonomic genius and a born field-worker, but his enthusiasm for collecting and minute critical analysis was controlled by the wider outlook of a true man of science His exploration of Newfoundland, the Gaspé Peninsula and adjacent areas led to the publication of two papers which have become classics "Persistence of Plants in Unglaciated Areas of Boreal America" (1925), and "Specific Segregations and Identities in some Floras of Eastern North America and the Old World" (1931) In later years he had concentrated on south-eastern Virginia, a region where northern and southern floras meet and overlap

Fernald loved the most highly critical genera, such as *Antennaria*, *Solidago*, *Salix*, *Carex*, and the family Gramineæ. His most finished monographic work was on the linear-leaved North American species of *Potamogeton,* Section *Axillares* (1932), and on *Draba* in temperate north-eastern America (1934) But the tremendous grip of his understanding and experience lay on almost every group occurring in his area, and woe betide the young student who rushed into print with ideas that did not work. At the same time, he held balanced, scholarly views on questions of nomenclature and orthography, such as well became him as an upholder of the conservative tradition of the Gray Herbarium Fernald was a 'character', with strong convictions which made him a ready and voluminous writer, even by American standards. Fortunately, he was one of the really great systematists of our time All his taxonomic knowledge is suitably gathered together in his great book, the eighth (centennial) edition of Gray's "Manual of Botany", which appeared not long before his death (forty-two years before, with Robinson, he had revised the seventh edition) He was honoured by many societies in the United States and northern Europe, and was honorary vice-president of the recent International Botanical Congress at Stockholm

N Y SANDWITH

WE regret to announce the following deaths

Dr R S Clark, formerly director of the Scottish Home Department Marine Laboratory, Torry, Aberdeen, and naturalist on Shackleton's Antarctic Expedition of 1914–16, on September 29, aged sixty-eight

Mr C E C Fischer, formerly of the Indian Forest Service and the Kew Herbarium, on October 19

# NEWS and VIEWS

## Nobel Prize for Physics for 1950: Prof C F Powell, F R S

PROF C F POWELL, Melville Wills professor of physics in the University of Bristol since 1948, who has been awarded the Nobel Prize for Physics for 1950, was educated at Judd School, Tonbridge, and Sidney Sussex College, Cambridge Following upon a first in physics in the Natural Science Tripos, he worked under C T R Wilson on the condensation of steam From Cambridge he went in 1928 to Bristol, in the first place as research assistant to Prof Tyndall, where he was jointly or independently the author of papers on the mobility of gaseous ions But it was afterwards as lecturer and reader that he initiated experiments to which he brought high technical skill and which have gained him wide recognition In 1938, having built a Cockcroft generator to start work in nuclear physics, he tried an old method of observing the tracks of particles by shooting them into a photographic emulsion Contrary to the opinion then held, he showed that under properly controlled conditions the method could be made to give quantitative data on nuclear processes and at an enhanced speed Attempts to secure special emulsions were interrupted by the War , but when these were later available, the method forged ahead rapidly In particular, Powell made a concentrated attack, from plates exposed at high mountain altitude, on the problem of the primary cosmic rays In his laboratory, with its team of trained women scanners and collaborators like Occhialini and others, a stream of publications has issued Of these, his discovery with Occhialini and Lattes of the heavy $\pi$-meson is perhaps one of the most important in its influence on present trends But even more so is the instrument itself, a combination of a photographic emulsion and a microscope which he has fashioned and perfected into a tool of precision and the widest application in nuclear physics

## Nobel Prize for Literature for 1950 · Earl Russell, O M , F.R S.

THE award to Earl Russell of the Nobel Prize for Literature in 1950 is an event at once gratifying and revealing Over the years, men of science, and the general public no less, have come to regard him as seer, savant and expounder , unique perhaps in his power to achieve high place in the grand debates of our age But this is the Bertrand Russell of the Reith Lectures and kindred accomplishments, both here and overseas The other—and maybe the real image rather than the virtual image—is the distinguished part-author of "Principia Mathematica", the Cambridge scholar at the height of his powers, driving, as it were, piles into the foundations of thought, to make the whole edifice not only more stable but also more beautiful It is this æsthetic quality in his writings that makes him fit so appropriately with his fellow-prizemen in literature The Nobel Foundation does not provide specifically for outstanding contributions in mathematics and philosophy , but if it did, the inclusion of Bertrand Russell's name in such a universe of discourse would scarcely escape anomaly, in view of his labours to reduce mathematics to logic Possibly more by chance than by design, he comes to be in the right place The theory of types and the clarification of paradox place their author well and truly among those who have created great literature, and in that category (but not excluding others) he is assured of universal felicitation upon his latest honour

## Tribute to Dr. J A. Murray

THE Royal Microscopical Society conferred an honorary fellowship on Dr J A Murray in April 1949 In the June issue for 1950 of the *Journal of the Royal Microscopical Society,* a foreword by the president, Dr R. J Ludford, pays tribute to his friend and former teacher who, as the second director of the Imperial Cancer Research Fund, guided the activities of that organization through an early critical period The contents of the *Journal* consist of seven papers by former colleagues of Dr Murray who are, or were at one time, members of the staff of the Imperial Cancer Research Fund The very high standard of these papers, and in particular the beautiful illustrations that accompany them, is an appropriate tribute to one who has done so much for the science of microscopy It is not the purpose of this note to attempt to summarize the several papers , but the two papers by Ludford and Smiles seem to call for special comment, as they illustrate in the most striking and convincing way the relative merits of ultra-violet and of phase-contrast microscopy Both techniques are superbly illustrated and justify in a remarkable way the well-tried techniques of fixation and staining for revealing minute cell structures

## Kelvin Medal Award: Prof T von Kármán, For.Mem.R.S

THE Kelvin Medal Award Committee, consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute, has awarded the Kelvin Gold Medal for 1950 to Prof Theodore von Kármán, of the California Institute of Technology, in recognition of the eminent services he has rendered to engineering science in those branches of engineering with which Lord Kelvin was especially identified, and to commemorate which this Medal was instituted The Kelvin Gold Medal is awarded triennially, the last award being to Sir Frank Whittle in 1947 Prof von Kármán is an authority on the mathematical theory of hydrodynamics and aerodynamics and its applications, and was elected a foreign member of the Royal Society in 1946 (see *Nature,* **157,** 688, 1946)

## University College, Ibadan. Endowment Fund

THE Nigerian Cocoa Marketing Board has contributed £1,000,000 to help endow the Department of Agriculture at University College, Ibadan The Board is to establish a trust to administer the fund and will also set aside £50,000 of the grant for initial expenditure on agricultural buildings and equipment This munificent gift follows a number of similar endowments made by the Board within the past three years £225,000 in 1949 to provide in perpetuity a total of fifteen free places for the sons and daughters of cocoa farmers at University College, Ibadan, £25,000 in 1948 to finance a survey of the economy of the cocoa-producing areas of Nigeria and, in the same year, subsidies to farmers in compensation for the cutting out of diseased trees amounting to £150,000, a £310,000 grant in 1947 towards the endowment of the West African Cocoa Research Institute During the course of the next few years the Board will also have helped to finance the building of new roads and to improve existing ones to the extent of £500,000 The Board has now given nearly £3,000,000, since its formation in 1947, for the benefit of Nigerian cocoa interests Other costs for buildings and equipment at University College, Ibadan, are being met with a grant of £1,500,000 by the United Kingdom Government Current expenses for a period of five years have been guaranteed by an annual grant of £100,000 from the Nigerian Government, which is also making an initial grant of £250,000 to the College Endowment Fund

## Cotton Research Station, Namulonge, Uganda

IN the presence of many distinguished guests, among whom were representatives of the Colonial Office, the Cotton Board, the Raw Cotton Commission and the East African High Commission, together with agricultural officials from the cotton-growing Colonies of the British Commonwealth, the Sudan and from French, Belgian and Portuguese territories in Africa, the new Cotton Research Station at Namulonge, Uganda, of the Empire Cotton Growing Corporation was officially opened by the Governor of Uganda, Sir John Hathorn Hall, on November 9 The Station is staffed by the Corporation, and the capital cost and running expenses are found by the Colonial Development and Welfare Fund, the Cotton Industry War Memorial Trust and the Raw Cotton Commission, besides the Governments of the British cotton-growing Colonies in Africa, the Sudan Government and the Corporation itself, assisted by a grant from the Cotton Board The Station, sixteen miles from Kampala, comprises more than 2,200 acres of land, of which it is hoped that 1,500 acres will eventually be under cultivation The main building consists of laboratories totalling 15,000 sq ft in floor area and split up into sections to house the various scientific departments The work of the Station will not be confined to the Uganda crop, but will also cover basic problems affecting the other African territories Its establishment has been preceded by nearly twenty years of important research in Trinidad into the life-history of the cotton plant, and by even longer periods of practical work at experiment stations in South Africa and elsewhere in the Commonwealth At present, in addition to Uganda, the staff of the Corporation are stationed in the Sudan, Tanganyika, Nyasaland, Nigeria and the West Indies, where they work in close co-operation on cotton breeding and the many other problems which confront the grower

## Nigerian Broadcasting Service

MR T W CHALMERS, controller of the Light Programme of the British Broadcasting Corporation, has been appointed head of the new Nigerian Broadcasting Service He will have to build up a system that will cover 370,000 square miles, providing broadcasts in at least ten different languages to a population of 25 millions He will have to encourage the formation of community receiving centres in remote villages, and the import and sale of cheap radio sets such as the so-called 'saucepan special' which has been well tried in Northern Rhodesia There is at the moment only one wireless transmitting station in the Colony, 'Radio Nigeria', a low-power experimental unit situated in Lagos and serving some 1,800 listeners, who, however, can also receive the programmes of the B B C 's Overseas Service In addition, daily programmes are transmitted over a wired broadcasting system from local studios to ten towns in the Colony, where they can be heard on 9,300 loudspeakers Only 0 2 per cent of the population can listen to broadcasting of any kind The present scheme is designed to expand the transmission of programmes, both by radio and line Two broadcasting engineers, Mr L W Turner, of the B B C, and Mr F A W Byron, of the Crown Agents for the Colonies, carried out a technical survey last year under the auspices of the Colonial Office and the Nigerian Government. Six wireless stations will be built at a capital cost of about £350,000, to be shared by the Nigerian Government and the United Kingdom, the latter making a grant under the Colonial Development and Welfare Act Work will begin at once on two short-wave stations at Lagos and at Kaduna in the north These stations should be working within eighteen months, and another short-wave and the three medium-wave stations will follow later

## Royal Society of South Africa: New Fellows

THE following have been elected fellows of the Royal Society of South Africa Dr G W Bond, for investigations in geochemistry, the chemistry of ground-water, the treatment of water supplied for power production and corrosion problems arising therefrom, Dr J Day, for zoological research, more especially in the fields of marine biology and ecology, Prof G A Elliott, for research into cardiology and rheumatoid arthritis, and for his administrative work as professor of medicine in the University of the Witwatersrand, Dr L King, for work on geomorphology, surface geology and other geological subjects in New Zealand and in South Africa

## Fourth Congress of the International Scientific Film Association

THE Fourth Annual Congress and Festival of Scientific Films of the International Scientific Film Association was held in Florence during October 14–22 The following officers were elected for 1950–51 *President*, John Maddison (Great Britain), *Vice-Presidents*, Luc Haesaerts (Belgium) and Jan Korngold (Poland), *Honorary Secretary*, Jean Painlévé (France), *Honorary Treasurer*, Mario Ponzo (Italy) Among the most important decisions reached during the Congress were those dealing with the setting up in Brussels of the first International Reference Film Library of scientific films, the adoption of a standard system of recording, and interchanging internationally, information about scientific films, and the production by international effort of a film on meteorology, for which a first treatment has already been prepared Valuable progress on the part of the Research Committee and the Medical Committee was reported Great Britain was represented by a delegation of ten members, including representatives of the Scientific Film Association of Great Britain, the British Council and the Royal Photographic Society Great Britain also contributed about thirty per cent of the total of some one hundred and twenty films on a wide variety of subjects which were shown The technical excellence and the scientific qualities of all of the films, in comparison with those shown in previous years, have given proof of a considerable advance in the production of this type of film

## Conference on Evolution and Education

A CONFERENCE on "Evolution and Education", sponsored by eleven scientific and social organizations, will be held in the Chemistry Lecture Theatre, University College, London, during December 8–9 The following papers (some followed by discussion) will be read "The Evolutionary Process" (Dr. Julian Huxley), "The Teaching of Evolution" (Miss M L Johnson, Miss E L Buckley, Mr R Weatherall), "School Broadcasting and Evolution" (Mr Richard Palmer), "Evolution and Christian Belief" (Dr W H Thorpe), "Modern Views on Evolution in the Light of Recent Advances in Embryology" (Dr G R de Beer) Further information can be obtained from the British Social Biology Council, Tavistock House South, Tavistock Square, London, W C 1

## Conference on Homes and the Family

THE British Committee of the International Union of Family Organizations, which comprises seventeen scientific and social institutions, is arranging a conference on "Homes and the Family" to be held on November 23 at the Caxton Hall, London The first session will deal with "The Housing Needs of the Family", and will be held under the chairmanship of Prof Winifred Cullis Mrs Graham-Bryce will take the chair at the second session, which will deal with "Housing and Health the Medical and Moral Effects of the Problem on the Family" Further information can be obtained from the Honorary Secretary, British Committee of the I U F O, c/o British Social Biology Council, Tavistock House South, Tavistock Square, London, W C 1

## Scottish Postgraduate Agricultural Scholarships

THE Department of Agriculture for Scotland has awarded the following postgraduate agricultural scholarships, commencing this year and tenable as shown *Husbandry*, A O Ballantyne (University of Edinburgh), H G Livingston and J W Stoddart (University of Reading), *Agricultural Economics*, G F B Houston and S G Strachan (Agricultural Economics Research Institute, Oxford), *Statistics*, St C S Taylor (University of Edinburgh) The Department has extended five current awards for a further year, as follows *Husbandry*, A G Campbell (Massey Agricultural College, Palmerston North, New Zealand), C D Reekie (Cornell University), and Miss M I Ore (University of Edinburgh), *Agricultural Engineering*, G T Ward (King's College, Newcastle upon Tyne), *Agricultural Economics*, K A Ingersent (University of Minnesota)

## *Lenzites thermophila* Falck

DR W H WILKINS, of the Mycology Laboratory, Oxford, writes "Mr K St G Cartwright, of the Forest Products Research Laboratory, Princes Risborough, has directed my attention to the name *Lenzites thermophila* Falck 75 in Dr H S Burton's communication published in *Nature* of September 30, p 570 In 1946 I received from the Forest Products Laboratory three cultures labelled respectively by that Laboratory, *L thermophila* Falck 75, *L thermophila* Falck 75A and *L trabea* (Pers ) Fr 108 In view of this I ignored the note by Cartwright (*Trans Brit Mycol Soc*, **16**, 304, 1931) and the confirmation by Mounce and Macrea (*Canad J Res*, **14**, 215, 1936) that *L thermophila* Falck was synonymous with *Lenzites trabea* (Pers ) Fr, which latter name has priority I apologize to Dr Burton for having misinformed him on this point "

## Announcements

MR JAMES WILKIE, secretary of the Carnegie United Kingdom Trust, has been elected president of the Library Association for 1951 in succession to H.R.H the Duke of Edinburgh The next annual conference of the Association will be held in Edinburgh during June 4–8, 1951

THE Gulland Laboratory of the Scottish Seaweed Research Association at Inveresk Gate, Musselburgh, will be officially opened by the Right Hon Hector McNeil on November 24

THE first annual report of the Commonwealth Scientific and Industrial Research Organization, for the year ended June 30, 1949 (pp 137, Canberra. Commonwealth Government Printer, 1949, 7*s* 9*d* ), of which a multilithographed copy was tabled in Parliament by the Organization's Minister last year (see *Nature*, April 29, p 677), has now been printed, and copies are available for distribution

A COURSE of four lectures on ecology, arranged by the Association of Agriculture, will be held at the University of London Institute of Education, Malet Street, London, W C 1, two lectures being given during each of the mornings of December 9 and 16, commencing at 10 a m The emphasis of the course will be on ecology in agriculture and in school teaching, and the speakers will be Sir James Scott-Watson, Mr A P Weller (Oxford Education Committee), Dr A S Thomas (Nature Conservancy) and Prof J E Nichols (Aberystwyth) The fee for the course is 2*s* Applications should be sent to the general secretary of the Association of Agriculture, 238–40 Abbey House, 2 Victoria Street, London, S W 1

# A PLANT VIRUS THAT MULTIPLIES IN ITS INSECT VECTOR

By L. M. BLACK
Brooklyn Botanic Garden, N.Y.

EXPERIMENTAL evidence for the multiplication of two plant viruses in their insect vectors has already been published by Fukushi[1-3], Kunkel[4,5] and Black[6]. Bawden[7] has adversely criticized this evidence in his book on plant viruses and the diseases they cause. It is not the purpose of this article to discuss the criticism of these earlier experiments, but to record briefly the main features of experiments with a third plant virus which are believed to leave no doubt about its ability to multiply in both its plant hosts and insect vector. These experiments were begun at the Rockefeller Institute for Medical Research, and since 1946 have been continued at the Brooklyn Botanic Garden.

The clover club-leaf virus, *Aureogenus clavifolium* Black[8], was shown to pass through the egg of its insect vector. Virus-bearing female leafhoppers, *Agalliopsis novella* (Say), were caged on Grimm alfalfa plants, *Medicago sativa* L., which are immune to the virus. Thirty nymphs were removed from the alfalfa plants as they hatched from the eggs deposited in the plant by the insects. Great care was taken to ensure that the young insects had no opportunity of feeding on the plants in which the eggs had been laid.

Each nymph was placed on a crimson clover seedling, *Trifolium incarnatum* L., and transferred at weekly intervals to a fresh seedling until it died. The clover test plants, which are susceptible to club-leaf, were observed in the greenhouse along with an equal number of uninoculated controls. None of the controls became infected, but 68 of 642 of the test plants did. These 68 plants were infected by 24 of the 27 insects that survived more than two weeks. None of the 24 insects infected plants until at least three weeks had elapsed from the time of hatching.

On February 8, 1945, a virus-bearing female leafhopper weighing 1·7 mgm. was mated with a virus-free male and the pair caged on an alfalfa plant. The alfalfa plant was grown in soil that had been steamed to kill weed seeds. The female produced 42 nymphs, of which 21 were tested individually on a series of four crimson clover plants and then discarded. Fifteen of the 21 produced infections. Therefore, on the average, the virus in the original female had been diluted approximately 1 : 30 among her progeny. The 21 remaining progeny were each placed on an alfalfa seedling, and when they became adults, the females were mated to virus-free males. The virus has a long incubation period in crimson clover, and in each generation insects had to be mated before any infectivity data were obtained on their sibs. The pair that produced the greatest number of progeny was chosen to continue the main line of descent. This was done in order to have a basis for selection that was independent of virus concentration and, also, to secure the greatest dilution possible. Usually in each generation about thirty pairs of insects were mated.

The family with the greatest number of progeny was chosen for the main line of descent and four supplementary families with more progeny than others and close to the main line were held in reserve. (The use of the word 'family' is restricted in this communication to a pair of insects and their progeny.) These supplementary families were discarded as soon as it was known that virus was present in the main line of descent. Ordinarily, in each generation a sample of about fifteen progeny from each of these five families was tested individually on crimson clover to determine the fraction that was infective. With some exceptions, each of these insects was fed in succession on each of three plants for three weeks. Another sample of about ten nymphs from each of the same five families was distributed, one nymph to each [illegible] a number of alfalfa plants, to provide females [illegible] continuing the line.

The experiment has been continued for more than five years through twenty-one generations of insects grown only on immune alfalfa without loss of infectivity. As shown in the accompanying table, the dilution of the original virus, assuming no multiplication in the insects, exceeded 1 : 2·8 × $10^{26}$.

CALCULATED MINIMUM DILUTION OF CLOVER CLUB-LEAF VIRUS DURING PASSAGE THROUGH THE EGG OF ITS INSECT VECTOR FOR 21 GENERATIONS

| Generation | No. of progeny | Infectivity test | Reciprocal of Dilution | |
|---|---|---|---|---|
| | | | Each generation | Total |
| 1 | 42 | 15/21 | 30 | 30 |
| 2 | 101 | 6/15 | 40 | 12 × $10^2$ |
| 3 | 35 | 3/15 | 7 | 84 × $10^2$ |
| 4 | 54 | 9/15 | 32 | 2,688 × $10^2$ |
| 5 | 60 | 3/15 | 12 | 32,256 × $10^2$ |
| 6 | 89 | 9/15 | 53 | 1,709,568 × $10^2$ |
| 7 | 104 | 6/15 | 42 | 71,801,856 × $10^2$ |
| 8 | 106 | 15/20 | 80 | 574,414,848 × $10^3$ |
| 9 | 64 | 3/20 | 10 | 574,414,848 × $10^4$ |
| 10 | 173 | 5/11 | 79 | 45,378,772,992 × $10^4$ |
| 11 | 88 | 6/21 | 25 | 11,344,693,248 × $10^6$ |
| 12 | 31 | 2/11 | 6 | 68,068,159,488 × $10^6$ |
| 13 | 52 | 0/15 | 0 (1)* | 68,068,159,488 × $10^6$ |
| 14 | 59 | 1/10 | 6 | 408,408,956,928 × $10^6$ |
| 15 | 129 | 1/5 | 26 | 10,618,632,880,128 × $10^6$ |
| 16 | 60 | 11/20 | 33 | 350,414,885,044,224 × $10^6$ |
| 17 | 114 | 2/15 | 15 | 525,622,327,566,336 × $10^7$ |
| 18 | 50 | 2/15 | 7 | 3,679,356,292,964,352 × $10^7$ |
| 19 | 107 | 1/10 | 11 | 40,472,919,222,607,872 × $10^7$ |
| 20 | 128 | 5/10 | 64 | 2,590,266,830,246,903,808 × $10^7$ |
| 21 | 105 | 1/10 | 11 | 28,492,935,132,715,941,888 × $10^7$<br>or 2·8 × $10^{26}$ |

* This was the only point where the absence of virus in the family with the largest number of progeny necessitated shifting the main line of descent to the family with the second largest number of progeny. It is an anomaly that the test of this latter family happened to be negative and that of the abandoned family (not shown) happened to be positive in this generation. In spite of the negative test at this point it is permissible to multiply the reciprocal of the dilution by 1 instead of 0 because the occurrence of infective descendants means that at least 1 of the progeny in this family was infected.

This dilution is a most conservative estimate, because it does not allow for systematic errors underestimating the dilution of the virus. For example, it does not allow for virus remaining in the mothers, for deaths among the progeny before they were counted, or for the fact that other data clearly show that the tests of the progeny did not reveal all those that were carrying virus. As an illustration, if the infective fractions as revealed by the tests were real, the families with the largest number of progeny in each generation should have been free of virus many more times than they were Also, several females from a family were sometimes saved and produced progeny that were tested Usually, all produced infective progeny A case in point is the main-line family in generation 19, only one of ten insects tested was infective (see table), but five sister insects which had been saved for progeny produced infective offspring

These experiments were controlled in several ways. The clover plants on which samples of insects from the main line were tested were matched in each generation with at least as many crimson clover control plants on which either no insects or virus-free insects had fed None of these plants became diseased Since none of the pots in which the caged alfalfa plants were grown ever produced weeds, the alfalfa was the only source of food for the insects After these plants had been freed of leafhoppers, they were tested for the virus by means of insects from one of two colonies The leafhoppers in these colonies had been obtained virus-free in one case by heat treatment and in the other by selection from insects collected in the field To date, virus-free insects after feeding on the alfalfa plants have failed to infect any of 431 clover plants, whereas comparable insects, after feeding on club-leaf clover, have infected 148 of 406 test plants

That the club-leaf virus multiplies in plants was shown by an experiment begun on November 12, 1943 Scions of *Vinca rosea* L infected with the club-leaf virus were grafted on to healthy plants of the same kind The incubation period is long, but to date thirty passages in series have been obtained The symptoms of this disease in the flowers of *Vinca rosea* are unique, and they are the same after thirty passages as they are in plants freshly inoculated by insects

Dilution of the virus present in the original female to $1\ 28 \times 10^{26}$ without loss of infectivity must mean that the virus multiplied in the insect vector during its five-year stay on immune plants Assuming a particle weight for the virus as low as 10,000,000 and a concentration in the insect as high as 1 per cent, the female would have contained only about $1 \times 10^{12}$ virus particles Even a mass of hydrogen weighing the same as the original female (1 7 mgm ) contains only about $5\ 1 \times 10^{20}$ molecules

Some of the implications of a virus multiplying in both plant and animal hosts have already been discussed[6] It was pointed out that such a virus would really be both a plant and an animal virus, and would serve as a connecting link between the two groups, that the specificity of some insect transmission was probably dependent in part at least on whether the virus multiplied in a particular insect or not, that the incubation period in some leafhopper-virus combinations was probably due in part to multiplication of the virus in the vector and in part to the time required for its movement to the proper exit, that the occurrence of the same hypothetical large particle as virus precursor in both insect and plant was improbable It seems likely that most, if not all, plant viruses with long incubation periods in their leafhopper vectors multiply in those vectors. Several of these viruses have been demonstrated to pass filters retaining bacteria[9-11] and some have been demonstrated to be much larger than other types of plant viruses that have been studied[11-13]. The only one of these actually seen under the electron microscope has the appearance of a little organism[12,13]. It is possible that the ability of viruses in this group to grow in more diverse physiological media than some other plant viruses is related to this greater particle size

[1] Fukushi, T , *Proc Imp Acad Japan*, **11**, 301 (1935)
[2] Fukushi, T , *Proc Imp Acad Japan*, **15**, 142 (1939)
[3] Fukushi, T , *J Fac Agric Hokkaido Imp Univ* , **45**, 83 (1940)
[4] Kunkel, L O , *Amer J Bot* , **24**, 316 (1937).
[5] Kunkel, L O , *J Econ Ent* , **31**, 20 (1938)
[6] Black, L M , *Phytopath* , **31**, 120 (1941)
[7] Bawden, F C , "Plant Viruses and Virus Diseases" (3rd edit , Chronica Botanica Co Waltham, Mass , 1950)
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[12] Black, L M , Mosley, V M , and Wyckoff, R W G , *Biochim Biophys Acta*, **2**, 121 (1948)
[13] Brakke, M K , Black, L M , and Wyckoff, R W G (in the press)

# PHYSIOLOGICAL MECHANISM OF MILK SECRETION

AN international colloquium on the physiology of milk secretion, organised by the Centre National de Recherche Scientifique, Paris, with the support of the Rockefeller Foundation, was held in the Institut de Biologie Médicale, Strasbourg, during August 22–29, delegates attending by invitation from Belgium, France, Switzerland, the United Kingdom and the United States The scientific sessions occupied seven days, and senior members of the colloquium occupied the chair in turn A feature of the meeting was the cordial atmosphere which obtained throughout Members were unanimous in paying tribute to Prof M Klein, who was responsible for the organisation of the sessions and whose indefatigable efforts both before and during the colloquium were an important factor making for an outstandingly successful meeting The papers presented at the colloquium will in due course be published in full, together with as much as possible of the discussions, in a volume to be issued by the Centre National de Recherche Scientifique

The scientific proceedings were opened with a paper by Dr J Hammond, sen (Great Britain), who considered various stages of mammary development in relation to the levels of progesterone and œstrogen existing in the body, a preponderance of progesterone being held to favour alveolar growth and a preponderance of œstrogen leading to a secretory condition He contended that, in cattle, mammary growth from the time when sex hormones take over control from genetic organisers up to the twentieth week of the first pregnancy is decisive for subsequent milk yield In the discussion on this paper, the lack of data on sex hormone-levels in cattle, which would enable such a theory to be put to test, was stressed. Dr A T Cowie (Great Britain) described techniques used at the National Institute for Research in Dairying, Shinfield, for quantitatively studying mammary growth in the rat, guinea pig and goat, and reported recent experiments on artificially induced udder growth and lactation in spayed goats under the influence of œstrogen alone or plus progesterone.

Dr L Desclin (Belgium), discussing the effect of luteotrophic agents, prolactin and œstrogen, on the structure of the rat mammary gland, reported that in the presence of the ovary they promote alveolar growth but suppress secretion, while in its absence they evoke a secretory condition in the alveolar epithelium. These same luteotrophic agents were also discussed in relation to mammary growth by Prof M Klein and Prof G Mayer (France), who described mammary growth responses to them in the presence of physiologically different types of corpora lutea Prof G Mayer and Dr R Canivenc (France) described an interesting experiment in which a successful graft of placental tissue into the kidney of a female rat was accompanied by intense luteinization and the formation of mammary alveolar tissue engorged with milk, an outcome not easy to explain in terms of the results just mentioned Hormonal factors influencing normal mammary growth were also subjected to a penetrating analysis by Dr W R Lyons (United States), who showed slides illustrating the interplay of œstrogen and progesterone with anterior-pituitary and placental hormones in evoking pro-lactational mammary growth in the female rat

It was particularly gratifying and appropriate that Dr P Stricker (France), who, working with F Grueter in Strasbourg, discovered in 1928 the anterior-pituitary lactogenic hormone (prolactin), was able to be present to give a personal account of this important discovery, which opened a new era in lactational physiology Two other papers on the hormonal control of the secretory phase may be mentioned at this point Dr. W O Nelson (United States) described experiments on the hormonal initiation of lactation in the hypophysectomized guinea pig and brought forward new evidence that, at least in this species, œstrogens will inhibit lactation partly by depressing the prolactin output of the anterior lobe and partly by a direct action on the mammary gland Prof E Letard and Dr P Szumowski (France) described experiments on the artificial induction of lactation in heifers by treatment with synthetic œstrogens, and the stimulation of such lactation, once established, by treatment with iodocasein In the discussion on this latter paper, it was pointed out that the development in Great Britain of an improved method of synthesis of L-thyroxine in quantity has rendered iodocasein obsolete

Two papers dealt with pituitary cytology in relation to the lactating state Dr L Desclin (Belgium) described changes in anterior-pituitary cytology in relation to various factors, such as suckling, associated with the onset of lactation, and correlated these changes with the secretion of the luteotrophic and lactogenic hormone, prolactin Morphological changes in pituitary tissue grafted into the kidney were also considered Prof R Collin and Dr J Racadot (France) reported a correlation between the lactating state and the appearance of 'Herring' bodies in the hypophysis of the guinea pig

Cytochemical studies on the mammary gland were discussed by Prof J Verne (France), who described the methods available and the results obtained by their use The staining of ribonucleic acid, neutral fat and glycogen in mammary tissue was discussed, and the results of Dempsey *et al*, who claim to have localized alkaline phosphatase in the capillary endothelium and myo-epithelium of the lactating gland, were described Mr K C Richardson (Great Britain), discussing this paper, wondered how far these last-mentioned results could be relied upon, in view of uncertainties now known to be associated with use of the Gomori histoenzymatic technique for alkaline phosphatase

A number of contributions on the biochemistry of milk secretion were presented Dr S J Folley (Great Britain) surveyed studies of the biochemical aspects of the endocrine control of lactation which have been carried out at Shinfield These studies, at first mainly concerned with changes in milk composition, and later focused on the interplay between hormones and mammary gland enzymes, are now concentrated on the intermediary metabolism of mammary tissue Some progress has been made in the study of the mechanism of milk fat synthesis, a process which seems to be to some extent under the control of insulin Dr F H Malpress (Northern Ireland) described experiments in which modern techniques have been applied to the question of *in vitro* lactose synthesis by mammary gland slices, and discussed his results in relation to various theoretical mechanisms of biological lactose synthesis, which remains one of the outstanding unsolved problems of carbohydrate biochemistry The biochemistry of milk fat synthesis was discussed by Dr T H. French (Great Britain), who reported recent experiments on the metabolism of glucose and acetic acid by mammary gland slices, which point to the importance of the latter as a substrate for milk fat synthesis, particularly in the ruminant He described tracer experiments carried out with G Popják which establish the formation of the lower fatty acids of ruminant milk by condensation of $C_2$ units arising from acetate Possibilities offered by the use of tracer isotopes in the study of milk secretion were considered by Prof H. Simonnet (France), who reviewed previous studies in the field He then described investigations with phosphorus-32 which indicate that the organic phosphorus of casein might originate from phosphopyruvate which could be transformed into phosphoserine by transamination and then integrated into the casein molecule He went on to report results on the respective rates of incorporation of phosphorus-32 into deoxyribonucleic acid and ribonucleic acid in the mammary alveolar cell The phosphorus of the nuclear deoxyribonucleic acid is less labile than that of the cytoplasmic ribonucleic acid, suggesting that milk is only synthesized when a definite relation between the rate of incorporation of phosphorus into the two types of nucleic acid is attained

The physiology of milking and suckling was reviewed by Dr M H I Macaulay (Great Britain), who made a critical survey of the evidence in favour of the currently accepted neuro-hormonal theory of the so-called 'let-down' of milk She concluded that this theory is by no means fully established yet Her evaluation of experiments involving interference with the neurohypophysis, as by stalk-section or by interruption of the supraoptico-hypothalamic tract, was particularly valuable, and her essay served to mark the probable path for future progress in this field In the subsequent discussion, Dr J Hammond reported that G W Harris and B A Cross had succeeded in evoking 'let-down' of milk in the lactating rabbit by direct electrical stimulation of the pituitary stalk Mr K C Richardson (Great Britain) gave a paper describing the morphology of the myo-epithelial cells forming a network round the mammary alveolus, cells which he has been able to figure adequately for the first time by means of a special silver-impregnation technique developed by him He discussed the probable function of these cells in relation to the 'let down' of milk and presented evidence consistent with the view that during milking they actively contract and squeeze milk from the alveolar lumen rather than passively fold up as the alveoli collapse He reminded those present at the colloquium that direct and conclusive evidence that these cells contract in response to oxytocin (the essence of the neuro-hormonal theory) remains to be provided

The clinical aspect of lactation was introduced by Dr A Ginglinger (France) in a paper in which he discussed factors other than hormonal ones which adversely affect lactation in women Here the stress was mainly on social pressures arising from contemporary conditions of civilization which tend to make many women reluctant to suckle their infants The lively discussion which followed ranged widely and touched also on the related subject of adverse psychological factors which, by interfering with the neurohormonal reflex concerned in milk ejection, could seriously prejudice the success of lactation The colloquium concluded with a paper of unusual interest by Dr R Deanesly and Dr A S Parkes (Great Britain), who have collected reports by anthropologists, medical missionaries and other such observers, of methods practised among primitive peoples, for the purpose of inducing lactation in non-parturient women or improving lactation already established A common feature of most of these reports is the administration to the subject of certain plants or plant preparations often accompanied by manipulation of the nipples to mimic the suckling stimulus Though well-authenticated confirmation of the galactogogue properties of such plant preparations is entirely lacking, nevertheless the authors considered that the reports are sufficiently consistent and their sources so widespread as to justify a well-controlled investigation of the whole question by an expedition composed of experts qualified in the relevant scientific fields S J FOLLEY

# INDUSTRIAL RADIOLOGY

THE Summer Meeting and Exhibition arranged by the Industrial Radiology Group of the Institute of Physics was held during the last week of July in the New Horticultural Hall, London Accommodation was provided by the organising committee of the Technical Exhibition of the International Congress of Radiology held in London during the same period

The meeting opened on July 25 with a paper by Mr E E Smith (National Physical Laboratory) on "Industrial Aspects of Radiological Measurements" He discussed the changes likely to be made in fundamental units such as the 'rontgen' and the 'curie', and particularly how these will affect the industrial radiologist When the recommendations of the International Congress are published, it is hoped to arrange a further meeting of the Group to discuss this subject

On July 26 a paper was given by Dr W P Grove (Radiochemical Centre, Amersham) on the "Handling and Transport of Gamma-Ray Sources for Radiography" Dr Grove sketched the requirements for protecting both human beings and photographic materials from possible damage by gamma-radiation Regulations have been drawn up, in the light of these requirements, regarding the use of public transport for the carriage of materials emitting gamma-radiation

Mr B N Clack (Radiochemical Centre, Amersham) spoke on "Natural and Artificial Sources of Gamma Radiation" After sketching the requirements for radiography of various materials, he indicated to what extent these have been achieved with both natural materials and with radioisotopes produced in the pile, and went on to show the trend in design of exposure containers The lecture was illustrated by a number of slides of the plant at Amersham for making radiographic sources containing radon by adsorbing the gas on a small grain of charcoal in the manner originated by Dawson Mr Clack stated that radon is finding considerable application, because of the excellent quality of the radiographs obtained with it

One session which proved of great interest was a symposium on industrial radiology in countries outside Britain This opened with a paper by Dr E Dale-Trout (U S A ) on the "Characteristics of Lead Screens for Industrial Radiology", which contained much new and interesting information A Menetrier (Babcock and Wilcox, France) described the radiographic examination in France of welds in pressure vessels, and mentioned the general use of rod-type X-ray tubes placed inside the vessels for the examination of circumferential seams He said that radiographic examination has enabled high-tensile steel to be used for welded tanks for the transportation of liquefied gases, thus enabling the weight to be reduced to one half R P Barbotin (Kodak-Pathé, France) spoke of post-war difficulties, but said that rapid progress is now being made, and a high standard of radiographic technique can be ensured by the use of high-contrast fine-grain film D J Binkhorst (Rontgen Technische Dienst, Holland) demonstrated a very convenient pack containing reference sets of penetrameter radiographs and comparative density films for use by inspectors when viewing radiographs Mr Å Junghem (Sweden) described the work of the Central Institute of Radiology founded in Stockholm in 1937 He maintained that radiographic quality control need not be more expensive than mechanical testing, and said that it is proposed shortly in Sweden to substitute 'spot checks' by X-ray examination of structural welds in place of the usual routine mechanical tests K Koren (Norway) announced the formation about twelve months ago of a Central Institute in Norway for weld radiography, the chief application of industrial radiology in Norway is in the examination of pipe welds in hydro-electric plant H Vinter (Denmark), director of the Akademiet for de Technische Videns Kaber in Copenhagen, spoke of the work of this newly established Institute He showed illustrations of a very unorthodox portable X-ray equipment, every part of which can be carried by one man and passed down the hatchway of a ship The equipment was shown in use in various simple arrangements for the examination of ship welds The design requirements of the equipment were that there should be no high-tension cables, no external coolers, and that it should be weatherproof, in fact, the control table will operate when immersed in water The larger of two models operated at a maximum voltage of 170 kV with a tube current of 2 milliamp

At another meeting there was a symposium on the subject "What is the Use of Industrial Radiology ?" The meeting opened with a thoughtful contribution by Mr B R Byrne (Railway Executive, Southern Region), who emphasized the great care necessary by industrial organisations in the selection of radiographic equipment, in the training of operators and in the choice of consultants Mr G T Harris (Wm Jessop and Sons, Ltd ) said that far more work is needed to correlate radiographic findings with the mechanical strength of the material, and to compare various methods of non-destructive testing He gave results of tests on turbine disk forgings of austenitic steel which showed satisfactory agreement between radiography, ultrasonic examination and tensile tests. Mr J C Rockley (A I D Test House, Harefield) referred to the well-known radiographic inspection of stressed castings for aircraft and described three other useful applications detection of internal corrosion in aircraft fuel tanks , detection of faulty assembly of pitot pressure heads , detection of metallurgical defects in cartridge cases

Dr H Harris (Babcock and Wilcox) stressed that the proper function of the radiographic examination of welded joints in pressure vessels is not so much to prove the acceptability of a particular weld as to correlate the weld with the test welds which are subject to mechanical tests The greatest value of radiography is in developing welding processes rather than as a routine method of inspection

Mr H S Peiser (Hadfields, Ltd ) said that the fact that his firm is spending some £15,000 on a new radiological laboratory is evidence of its belief in the value of industrial radiology Mr J F Hinsley (Edgar Allen and Co , Ltd ) spoke of the expansion of the radiological facilities of the firm which he represents He referred to a very important radiographic examination of castings for the housing of electric traction motors, etc , and described the methods of repairing surface irregularities by welding Mr S M Reisser (Murex, Ltd ) stressed the importance and the difficulty of attaining uniformity in radiographic interpretation, and emphasized that full details of radiographic technique are essential for accurate interpretation

An exhibition of industrial radiology arranged by Dr D H Follett (Science Museum) was held throughout the week Some fifty exhibitors contributed to it, including the British Standards Institution, Mr F I G Rawlins of the National Gallery (who demonstrated the radiography of oil paintings), and Dr C Moss of the British Museum (who showed archæological radiographs) There was also a variety of radiographs illustrating the use of radio isotopes, auto-radiography, flash radiography, and radiography with a 1 4-MeV synchrotron There were several photographs of radiographic equipment, including one of an X-ray laboratory in a railway coach, shown by Mr. Knights and Mr Dearden of the Railway Executive, Midland Region Apparatus was shown for the radiographic examination of pipe welds. One piece of apparatus exhibited enabled the level of mercury in a steel manometer tube (made necessary because the pressure is too great for glass to withstand) to be read by sending a beam of gamma-rays through the tube and detecting it with an ionization chamber and cathode-ray tube The Armament Research Establishment of the Ministry of Supply exhibited a new type of sensitive penetrameter devised for use in the radiographic examination of welded joints The same Establishment also exhibited a container for use in gamma-radiography, made from tungsten alloy to minimize the transmitted radiation The operator can allow gamma-rays to emerge when required by an automatically released 'stopper', while remaining shielded from the radiation himself It is suitable for sources up to 1 curie in strength, and the source is automatically returned to a safe position when the container is raised on completion of an exposure One of the radiographs, taken with an exposure of one-millionth of a second, showed a bullet travelling through water

# PLANT BREEDING IN GREAT BRITAIN

THE fourth annual conference of British plant breeders was held at the Scottish Plant Breeding Station, Corstorphine, Edinburgh, during August 3–4 and was attended by representatives of the John Innes Horticultural Institution, Bayfordbury , the Plant Breeding Institute, Cambridge , the Welsh Plant Breeding Station, Aberystwyth , the Plant Breeding Division, Ministry of Agriculture, Belfast , the National Vegetable Research Station, Wellesbourne , the Scottish Society for Research in Plant Breeding, Edinburgh , the Department of Agriculture for Scotland , and the Agricultural Research Council. At the conclusion of the conference, the invitation of Dr C D Darlington, director of the John Innes Horticultural Institution, Bayfordbury, to hold the next conference at Bayfordbury in 19 was accepted

Sir John H Milne Home welcomed the visitors on behalf of the board of directors of the Scottish Society for Research in Plant Breeding, and Sir Patrick Laird on behalf of the Department of Agriculture for Scotland Mr William Robb, director of research of the Scottish Society for Research in Plant Breeding, opened the proceedings by giving an account of the origin and organization of the Society, and the first morning of the conference was devoted to giving in turn an outline of the work of the various departments—cereal breeding by Mr Robb, herbage breeding by Dr. J W Gregor, potato breeding by Dr William Black, potato virus diseases investigations by Dr G Cockerham, and swede and sugar beet breeding by Dr V McM Davey The afternoon of August 3 and the morning and afternoon of August 4 were divided into five sessions, in which the party visited in turn the experimental plots of these departments, spending the morning of August 4 at the Potato Breeding Sub-Station at Boghall

*Cereals and Beans* In the breeding work with oats, the pedigree method of breeding has been mainly followed, but the 'bulk' method is now being tried The main problems are to breed by hybridization and selection oats which are productive, disease-resistant varieties highly resistant to lodging and having good quality milling grain which possesses resistance to germination at harvest time , hardy, early-ripening types for upland areas , and varieties showing a higher degree of tolerance of alkaline soil conditions than most standard varieties at present in cultivation

A large number of unfixed hybrids were seen in plots in various stages of development, ranging from the first to the sixth generation Attention was directed to various selections to illustrate the progress made in breeding for shorter straw and resistance to lodging, early-ripening types for upland areas, selections resistant to sprouting in the ear, and a selection adapted to alkaline soil

Interest was shown in a number of transgressive segregates which illustrated wide genetical differences in length of straw and type of ear The methods followed in testing the Society's new varieties at the Station, and at other centres in various parts of the country in co-operation with the three agricultural colleges in Scotland, were referred to, and the system followed in putting the Society's new varieties into commerce was outlined

Mr D Cameron and Mr H D Garvin demonstrated the work being done at the Station with barley and beans, and described that on the production of polyploid oats by means of colchicine and acenaphthene. An *Avena sativa* having a duplicated set of chromosomes obtained by colchicine treatment of the seed, and a duplicated *Avena strigosa* obtained by the immersion of the coleoptile in colchicine solution were shown. Crosses between these two duplicated types have given a number of grains, presumed to be the amphidiploid.

A sterile hybrid between *A. barbata* and *A. strigosa* was shown, from which some twenty seeds have been obtained this year following acenaphthene treatment in 1949, and the material will be examined cytologically.

With barley, a problem is to breed a malting barley with a low dormancy and suitable for combine harvesting. Attention was directed to a few hybrids in the $F_3$ generation which had been selected for low dormancy at harvest time, from crosses between Scots Common barley types.

In field beans the object has been to produce early-ripening upstanding varieties with a high podding capacity and medium-sized round seeds suitable for machine sowing. Plants selected from an $F_2$ or from an open-pollinated mixed population were inbred for a number of generations by selfing them inside cotton bags to reduce variation, before multiplying the inbred line in spatial isolation to build up stocks sufficiently large for inclusion in field trials.

The Station equipment for threshing, cleaning, grading and husking oats was demonstrated to those interested in that aspect of the work.

*Herbage.* During the morning of August 3, Dr. J. W. Gregor discussed the relative merits of the bred strain and the regional race, and suggested that the usefulness of the regional race as a direct source of commercial seed should be given greater consideration.

In the afternoon, Dr. Gregor, Dr. P. J. Watson and Dr. F. Earnshaw enumerated some of the problems being investigated, and demonstrated some of the growing material. The investigations which were discussed are largely concerned with the major problem of utilizing hill vegetation efficiently. It was pointed out that where stock numbers are determined by the amount of winter food available, an increase in summer herbage production alone would be wasteful, and for this reason it was suggested that intensive cultivation of grass at the lowest elevation might meet the requirements of breeding animals better than extensive re-seeding of upland grazing. The problem, therefore, is primarily one of providing a rich supplementary feed for breeding cattle during the time when rough grazings remain unproductive; in other words, raising the level of nutrition by the complementary use of 'wild' and protein-rich cultivated herbage. What is wanted is a sown sward or swards able to provide protein-rich complementary grazing from mid-April until the end of May, and again in September and October, as well as silage or hay crops during the summer months. It was also mentioned that, given appropriate treatment, interesting changes in the vegetation can be effected and certain 'wild' plant communities can be used as protein-rich complementary grazing during the summer months.

Dr. Watson and Dr. Earnshaw dealt with some of the genecological investigations now in progress. This work, though primarily concerned with ecotypic differentiation and with the nature of the ecotype unit itself, has nevertheless a direct bearing upon the major problem of hill-land utilization. An endeavour is being made to study intensively the distribution of ecotypic variation along environmental gradients; and, in particular, attention is being paid to the spatial structure of intraspecific populations, and to the separation of ecotypic responses to altitudinal, edaphic and phytosocial gradients.

*Potatoes.* The potato-breeding work was described by Dr. Black, who explained that it is largely concerned with problems of disease resistance and with combining the different resistance qualities with the economic characters of commercial varieties. Natural resistance to each of the causal organisms of the more important diseases, blight, mosaics, leaf-roll, eelworm, scab and dry-rot, is to be found among the members of the potato family, and breeding experiments are designed to utilize the resistance factors as far as possible.

The problem of blight resistance was discussed in some detail, and methods of testing for resistance were demonstrated. In this work, seven different strains of the pathogen were employed for testing progenies derived from two main sources, namely, hybrids bred from *S. demissum* and *S. tuberosum*, and hybrids bred from *S. Rybinii*, *S. demissum* and *S. tuberosum*. Analysis of this material has shown that the blight resistance of *S. demissum* is controlled by at least four major independent genes which are inherited in simple Mendelian fashion.

The progress made in combining these genes with factors for resistance to other diseases was demonstrated in the field, where approximately a thousand selected seedlings have been grown in trial- and multiplication-plots for comparison as potential economic types.

Dr. J. C. Haigh demonstrated a number of species hybrids bred from *S. demissum*, *S. simplicifolium*, *S. acaule* and *S. tuberosum*, and explained their bearing on problems related to virus Y resistance and frost resistance. He also demonstrated the experiments laid out to study the effect of species and varieties on the soil population of the potato root eelworm.

*Potato Virus Diseases Investigations.* The subject of resistance to potato viruses was briefly reviewed by Dr. Cockerham, who dealt mainly with the genetic and breeding aspects of various forms of resistance to the *A*, *X*, *Y* and leaf-roll viruses. The methods of test used in recognizing and evaluating resistance characteristics were demonstrated, and attention was directed to a number of seedling varieties in which resistance to blight and virus diseases has been successfully combined. Current investigations being carried out by Miss T. M. R. McGhee and Mr. A. W. Macarthur on virus strains in relation to problems of resistance were explained in a demonstration of field-grown material infected with a series of strains of virus *X*.

*Swedes and Sugar Beet.* In discussing the breeding work with swedes (*Brassica Napus* v. *Napobrassica*), Dr. Davey described investigations which have been conducted since 1922 to test the possibilities of new breeding methods, and to attempt to obtain improved strains. Because the swede is potentially self-fertile, and seed propagated by the established trade method appears to be derived from both self- and cross-pollinations, a technique for the seeding of single plants in pollen-proof bags has been adopted. This technique was demonstrated.

At first, pedigree lines were established starting with plants selected from commercial crops, and some lines have been carried on for fourteen generations. Yield-trial results during the first twelve years indicated that about a third of the lines selected were worthless, while the remainder were not significantly better or worse than samples of their parent varieties. Improvement in uniformity was obtained, and it was concluded that the method might have some use in re-selecting contaminated stocks. Intervarietal crosses were made between the various swede types, and lines were selected which were also propagated by selfing. It was considered that these lines tended to become too uniform in their genetic constitution, so that after four generations it was difficult to effect any improvement in type or in performance. The intensity of inbreeding is now being lessened by intercrossing related phenotypes and by propagating one or more of the early generations as groups of mother plants in isolation. Selection for clubroot resistance is also being carried out on young plants grown in boxes of infected soil.

Investigations with sugar beet have been in progress for only three seasons. The yield of this crop in Scotland might be increased by sowing a few weeks before mid-April; but bolting would then become a serious consideration. Non-bolting sugar beet material under course of development at the Cambridge Plant Breeding Institute is being tested, and further selection and propagation is being carried out in collaboration with that Institute. A trial which included bolting and non-bolting material was demonstrated by Dr. Davey and Mr. F. J. W. England.

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# FIFTH INTERNATIONAL ANATOMICAL CONGRESS, 1950

THE Second World War was responsible for the cancellation of the Fifth International Anatomical Congress, which had been arranged to take place in Great Britain in 1940, and not until this year was it found possible to hold it. The previous Congress was in 1936 in Milan, so that another international meeting was much overdue; and thus the Fifth Congress was held in Oxford during July 25–28, under the auspices of the Anatomical Society of Great Britain and Northern Ireland, with Prof. W. E. Le Gros Clark as president.

Altogether, thirty-six countries were represented at the Congress, but, with the exception of Jugoslavia, which sent three members, there was no representation of any of the Eastern European countries. Even so, the 535 members who eventually came constituted a record attendance. A Government reception was held in Christ Church prior to the opening session, and the members were welcomed on behalf of the Government by Viscount Addison, who before leaving academic life was himself a professor of anatomy. In his presidential address the next day, Prof. Le Gros Clark reviewed current trends in the study of anatomy, and, among other things, emphasized the thinness of the largely artificial barrier between anatomy and physiology; his speech has been published in the *British Medical Journal* (ii, 233; 1950). At the University Convocation which followed the opening plenary session, honorary degrees were conferred on Lord Addison, Prof. G. W. Corner (Baltimore), Prof. M. W. Woerdeman (Amsterdam) and Dr. L. S. B. Leakey (Nairobi).

The subject-matter of the scientific sessions reflected the wide range of interests of modern anatomists, and emphasized the fundamental nature of the study of anatomy in relation to other biological subjects. Indeed, so varied was the content of the two hundred or so communications that it is difficult to make any useful summary; no official proceedings of the Congress are to be published. An attempt was made at rough classification into several groups: general anatomy, physical anthropology, neurology, histology, embryology and morphogenesis, and endocrinology; and, so far as possible, papers with related subject-matter were grouped together. This did not, however, prevent some strange juxtapositions. Thus, a paper on the mechanism of the interphalangeal joints in man was followed by one on the structure of the integument of the Anura; and a radiographic study of the mechanism of deglutition was succeeded by some remarks on the weak points of the lumbar region in Brazilian Indians.

In the section on neurology, which contained the greatest number of communications, there were two main groups, the first on the central nervous system, and the second on the peripheral nervous system and neurohistology. In addition, the greater part of two sessions concerned the peripheral parts of the autonomic system. The section on physical anthropology produced a spirited controversy regarding the origin and relationships of the Australopithecinæ, the observational evidence finding itself in conflict with the results of the more narrowly statistical approach. Among the other papers in this section were two dealing with the results so far obtained by the British–Kenya Miocene expedition. Under the heading of histology came several papers dealing with the application of phase-contrast microscopy to anatomical problems, and one whole session was devoted to papers dealing with bone. A number of new techniques were discussed, among them the use of microradiography and autoradiography. The section on embryology and morphogenesis included papers on experimental embryology and embryonic physiology as well as more purely descriptive papers. Lastly, in the endocrinology section, the main topics were the blood supply and functions of the pituitary and recent experimental work on the suprarenal cortex.

There were more than ninety demonstrations, involving some four hundred microscopes, and these, too, were roughly grouped together under headings. Here again, neurology was the heading under which came the greatest number of entries. Several films were shown, dealing with such diverse subjects as the tissue culture of osteoclasts and the recovery of skilled movements in monkeys after lesions in the motor cortex. An *ad hoc* discussion took place on the use of films in the teaching of normal anatomy, and in view of the difficulty, stressed by some Continental speakers, of obtaining material for dissection, it appears certain that there is scope for more and better teaching-films. The Congress resolved to form an international committee to approach the various and diverse sources known to be in possession of such films with the view to the formation of an international catalogue of available teaching material, and possibly the formation of a lending library.

It was also agreed to set up another committee, composed of delegates from the various national anatomical societies, to consider the difficult subject of modifying the present policy of *laisser-faire* with regard to anatomical terminology. The situation now is almost one of *tot homines, quot sententiæ*, since almost every nation has its own variant, usually, but not invariably, stemming from the great Basle Nomina Anatomica of the early years of this century. Any attempt to produce uniformity is, however, fraught with considerable danger, since anatomical terminology enters into many fields of research and classification, and it was felt that great care must be exercised before deciding to inflict any changes on the long-suffering clinicians, who in many cases have already probably had to master at least three different terminologies. It was also agreed, however, that the subject is one of such importance that an approach should be made to the United Nations Educational, Scientific and Cultural Organisation for the purpose of appointing a paid secretary to the committee.

The Congress coincided happily with an exhibition in the Radcliffe Science Library reviewing the history of the teaching of anatomy at Oxford, and a booklet on this subject was presented to each member. The official languages of the Congress were English, French, German, Spanish and Italian, and the interpreters were kept busy. For the most part the delegates were accommodated in Oxford colleges, and during their visit there was no lack of entertainment. Many members took part in sightseeing tours and visits to places of interest, on the last night there was a dance at Oriel College, which was well attended. There was plenty of opportunity for the exchange of informal views and speculations between members who had not seen each other for many years, and the fullest possible use was made of it.

At the closing plenary session, the president referred to the death of Prof. H. C. Bazett, of the University of Pennsylvania, on his way to attend the Congress. It was proposed by Prof. J. Benoit, on behalf of the Association des Anatomistes de Langue Française, that the Sixth International Anatomical Congress should be held under the auspices of the Association, probably in Algiers, in 1955. This invitation was cordially accepted by the members, as was the proposal of Prof. N. L. Hoerr that the American Association of Anatomists should be responsible for the succeeding Congress. The members then dispersed, many of them to pay visits to other laboratories in Great Britain, and all having enjoyed a very pleasant and stimulating few days.

# FLUORESCENT INKS FOR ADVERTISEMENT POSTERS

THE use in Great Britain in recent months of unusually brilliant coloured inks on advertisement posters has excited a good deal of interest and comment—some favourable and some otherwise. If, however, it be the purpose of a poster to invite attention, then these inks must be regarded as a success.

The underlying principle of the special inks used for these posters is that they contain a daylight fluorescent pigment which, because it fluoresces in the visible range, imparts the brilliance of colour. The fluorescent pigment is made by dissolving a small quantity of a fluorescent dyestuff in a transparent thermosetting resin (urea formaldehyde or phenol formaldehyde) and grinding the solid solution to a coarse powder. This pigment is then incorporated in a special printing ink containing coloured pigment and oil. Because fine grinding—the usual method of incorporating pigments in oil—destroys the fluorescent properties of the pigment, it is necessary that special inks be used, suitable only for a printing process known as 'silk screen printing'. The usual printing processes used for poster production—lithography and letterpress—demand finely ground inks, and for this reason the fluorescent inks cannot be used. Another reason for using the silk screen process is that it applies a much thicker film of ink to the paper than either lithography or letterpress, and this is an advantage, since the fluorescent inks are not 'permanent'. Even the best of the inks lose their effect after exposure for a month or so. Within limits, however, the thicker the ink film the more permanent is the ink, and hence the desire to print as much ink as possible.

The silk screen process has been used for a number of years for producing posters, showcards, folders, etc., where the number of copies is comparatively few, but the introduction of the new inks has extended the scale of operation considerably. The process is, in effect, a stencil printing process in which a thin ink—more like a paint than a normal printing ink—is forced through the mesh of a stencil made from a piece of silk stretched over a frame (synthetic fibres and wire mesh are also used). The stencil is made either by photographic means or is hand-prepared. The meshes in the image areas are left open, while those of the non-image areas are filled in. A stencil is made for each colour to be printed, and the ink is forced through the silk by means of a squeegee on to the sheet of paper beneath. Although the process can be made semi-automatic, a good deal of hand operation is involved, and hence to produce a large number of impressions is comparatively expensive.

The original patents covering these inks are American, and most of the inks used up to now have been of United States origin. The majority of ink makers in Great Britain, and on the Continent of Europe, are investigating their manufacture. The colours available to date are at the longer end of the spectrum—the reds, yellows and yellow-greens.

# CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE OF INDIA

THE official opening of the Central Glass and Ceramic Research Institute of India at Calcutta by the Honourable Dr. B. C. Roy, Chief Minister, Government of West Bengal, on August 26, brings to fruition a well-planned scheme launched by the Council of Scientific and Industrial Research in India and removes the long-felt and urgent need for the establishment of such an institution in India. This is the fourth laboratory established by the Council to be declared open—the other three being the National Chemical Laboratory at Poona, the National Physical Laboratory at Delhi and the Fuel Research Institute at Dhanbad.

An account of the plans for this latest research institute was given in *Nature* of March 1, 1947. Although the foundation stone of the Institute was laid on December 24, 1945, by the late Sir Ardeshir Dalal, then member of the Viceroy's Executive Council in charge of the Department of Planning and Development, it was impossible to start work until September 1948. Only the technological block had been constructed in 1948, where work has been in progress since then; important contributions on the availability and improvement in the quality of Indian raw materials for the glass and ceramic industries have already been made; a detailed account of these investigations was recently published. Researches on coloured glass, sintered glass and foam glass are in progress; the work on foam glass has aroused great interest.

The laboratory is located in Jadavpur, a southern suburb of Calcutta, and occupies a total floor area of about 45,700 sq. ft. The Institute with its imposing glass tower is a carefully designed and well-equipped laboratory providing facilities for team-work and for specialized research in glass and ceramics. The building consists of two blocks: the main block comprising laboratories for precision work, the library and the museum, and the technological block comprising units for processing raw materials, furnaces, workshops, etc. The building has many notable features. Special mention may be made of the armoured-plate glass doors, the first of their kind to be installed in India. The vestibule is decorated with a mural in cut glass in a single piece measuring about 6 ft. × 4 ft. and depicting the glass-blower's craft and potter's wheel, and an enamelled panel bearing the Council's insignia and the inspiring words of the Prime Minister of India, Pandit Jawaharlal Nehru, who is also president of the Council of Scientific and Industrial Research: "Do it now! I am not interested in excuses for delays, I am interested only in things done."

The museum (entrances to which are curtained by artistic glass fabrics) houses, besides specimens of raw materials and finished products of the glass and ceramic industries, many rare exhibits of historic interest. Excavated pieces of ancient Indian art from Mohenjodaro and Harappa, glass articles of the Moghul, Napoleonic, pre-Victorian and Victorian periods, specimens of historic interest from Westminster Abbey, Switzerland, France and Sweden, provide an array of exhibits spanning the long stretch of man's history. Of special interest to men of science are a double-ended discharge tube belonging to de la Rive, a Woulfe's bottle used by Davy and Faraday, an original heavy-glass prism made by Faraday, porcelain prisms and glass semi-cylinders employed by Sir J. C. Bose in his investigations, and a desiccator, a stone bottle and a measuring cylinder belonging to Sir P. C. Rây. A specimen of glass produced by the first atomic bomb explosion at New Mexico has been presented to the museum.

In a message read at the opening ceremony, the Prime Minister, Pandit Nehru, said: "The Central Glass and Ceramic Research Institute deals essentially with one of the most important applications of science. It will, I hope, play an important role in developing not only the glass industry in India, but many of its ramifications. Above all, I hope that this laboratory will nurture and spread the spirit of science so that we may grow out of our narrow selves and thus raise ourselves and our country to higher levels of thought and achievement."

Describing the need for such a laboratory, the Honourable Mr. Harekrushna Mahatab, Minister for Industry and Supply, Government of India, and vice-president of the Council of Scientific and Industrial Research, said: "The need of such an institute was felt during the last war. The human mind has been trained in such a way that unless there is a violent shock in the shape of a war, it is not stirred up to think of scientific research in various fields for the uplift of the human society as a whole. How one wishes that in peace-time, too, various researches were made and money could be available in abundance for the purpose."

Sir Shanti Swarup Bhatnagar, director of scientific and industrial research, Government of India, said: "The Council of Scientific and Industrial Research realized that glass and ceramic industries of India must be scientifically developed if they are to play the role they must, in the onward march of progress and achievement which, in our conviction, is India's destiny. . . . We have chosen Calcutta for the location of the Institute as it is one of the principal centres of the glass and ceramic industry. For the establishment of a successful glass and ceramic industry, we are as much dependent on science and technology as on decorative and creative art requiring delicate touches which only deft hands can impart; and as we know that Bengal possesses artistic talent which few other places can equal as well as scientific acumen of a high order, we feel we have acted rightly in locating the Institute here."

His Excellency Dr. K. N. Katju, Governor of West Bengal, presided at the opening, and in his address he blamed the politicians for the misuse of scientific discoveries. "We are now living in the atomic age fearful of what the future may unfold, and sometimes people blame the scientists for inventing and perfecting instruments of tremendous destruction, destruction as gigantic as is caused by an earthquake. For this abuse and perversion of human knowledge acquired by conquest over Nature we must not hold the scientists responsible. Responsibility for this must be placed fairly and squarely on the so-called statesmen of the world and on the people led or misled by them. Scientists discover, and this discovery has been a continuous process throughout the ages. It is for the people to decide how these discoveries are to be utilized, for the betterment of mankind or its destruction."

In declaring the Institute open, the Honourable Dr. B. C. Roy commented on the importance of having the right men in charge. They must be able to "create enthusiasm among the trainees and confidence in those who would be benefited by their research work. Dr. Atma Ram and his associates have established a reputation and I hope and trust that this Institute will have a succession of achievements to its credit."

Dr. Atma Ram, joint director of the Institute, defining the functions of the Institute, said that "although the functions of the laboratory are to some extent objective in character, one of the chief aims of the Institute "will obviously be fundamental research, because unless the workers are devoted to increasing the bounds of knowledge they will not be able to apply scientific ideas in the best way. The experience of laboratories elsewhere is that problems for fundamental research often reveal themselves during investigations of industrial problems. There is a host of such instances in glass and ceramics. At the same time, the Institute should not remain isolated and indifferent to the needs of the country and would endeavour to do its best to help the industry."

Some four thousand people attended the opening ceremony, including ministers and officials of Central and State Governments, eminent men of science, representatives of the glass and ceramic industries and others.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Structure within Polyhedra Associated with Insect Virus Diseases

For some time we have been examining with the electron microscope thin sections of caterpillars infected with their polyhedral diseases. In this way it is possible to follow the development of the disease, to see the crystal-like polyhedra as they are formed *in situ* and to observe the fine structure of their contents.

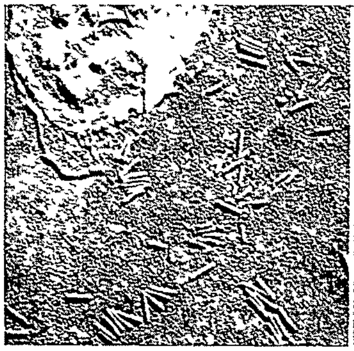

Fig. 1. Membrane and residual contents of an alkali-disintegrated polyhedral body from a diseased larva of *P. dominula*. The rod-shaped virus elementary bodies of uniform diameter are scattered over the substrate and can be seen within the membrane together with two of the thicker rods (near the bottom of the membrane) from which these virus particles come, as well as others in various stages of disintegration. Positive print. × 11,000

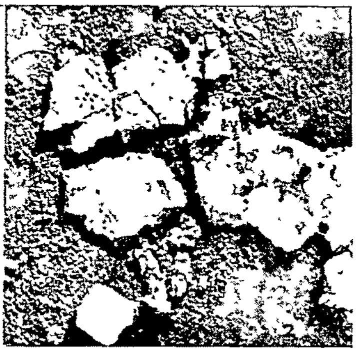

Fig. 2. Pitted debris of polyhedra treated with sodium carbonate, from *A. villaca*. The holes have essentially uniform diameters of the same order of magnitude as flattened spheres often observed on the surrounding substrate. Positive print. × 8,500

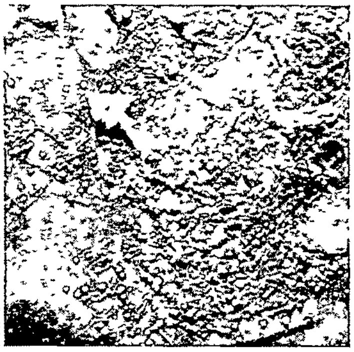

Fig. 3. Spherical particles, which may be elementary particles of virus, obtained by the alkaline disintegration of polyhedral bodies developed within a larva of virus-diseased *A. caja*. Positive print. × 8,500

Bergold[1,2] has obtained electron micrographs showing thin rods freed when polyhedra of the silkworm larva, *B. mori*, of the gypsy moth caterpillar, *P. dispar*, and of the nun moth caterpillar, *L. monacha*, are treated with dilute sodium carbonate. Presumably these are elementary bodies of virus. Similar rods have been obtained by Steinhaus and his co-workers[3,4] from polyhedra of the alfalfa caterpillar, the western yellow-striped army worm and the California oak worm. Treatment of the polyhedra from some of, but not all, the species of caterpillars which we have studied reveals similar rods.

Such rods have been obtained from the scarlet tiger moth caterpillar, *P. dominula*, and the currant moth caterpillar, *A. grossulariata*. In both these cases, alkaline disintegration has revealed thick as well as the thin elementary rods within and issuing from the membranes that enveloped the polyhedra (Fig. 1). As in this figure, the thin rods are frequently small groups in parallel array. In a few places the thick rods, which always have approximately the same length as the thin rods, are themselves disintegrating to reveal thin ones within them.

Polyhedra from other caterpillars, some belonging to species closely related to the foregoing, do not seem to contain these rods. Thus when the polyhedra from the cream spot tiger (*Arctia villaca*), the garden tiger (*A. caja*) moth caterpillars and the caterpillars of *Rhypara purpurata* are treated with sodium carbonate, there remain hollow shells of the polyhedra pitted with a large number of holes of very uniform diameter (Fig. 2). On the substrate surrounding these disintegrated polyhedra there can sometimes be seen clusters of spherical bodies having about the same diameter as the holes (Fig. 3). These spheres, often flattened, occur singly and in short chains. Similar holes and spheres can be seen within the polyhedra in sectioned tissues of the caterpillar itself. Unlike the polyhedra that yield rods, these usually show no evidence of enveloping membranes.

In all the caterpillars discussed here, the polyhedra developed within nuclei which may become so distended as nearly to fill their cells. This is true whether or not the rod-like particles are found. Fig. 4, from

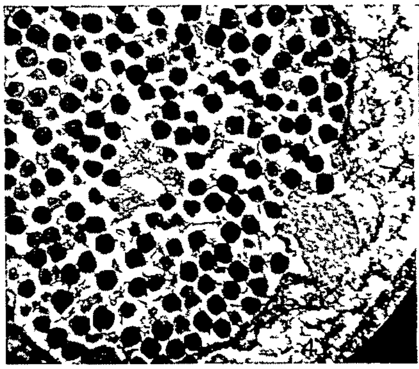

Fig. 4. Section showing part of a cell from a virus-diseased larva of *A. grossulariata* with almost all the nucleoplasm replaced by polyhedral bodies. Negative print. × 2,000

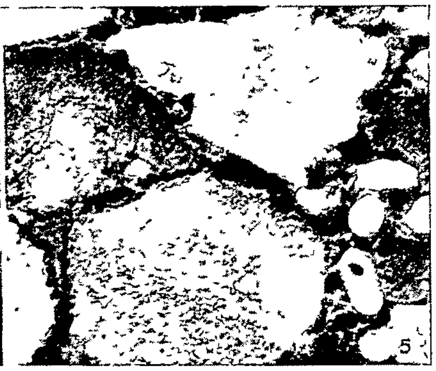

Fig. 5. Section through parts of spherical polyhedra within a cell of a diseased larva of *A. villaca*. The spherical pits disseminated through these bodies are easily seen. Positive print. × 11,000

a section through a diseased currant moth caterpillar, is typical of what is seen at low magnification under the electron microscope. The crystal-like outlines of the polyhedra are very evident in these sections. Fig. 5 shows several sectioned polyhedra from a cream spot tiger caterpillar. They exhibit the same pitting that is seen after alkali treatment. Sometimes there are protuberances in place of the holes. These facts, taken in connexion with what is seen in Figs. 2 and 3, suggest that the inclusions in these polyhedra are little spheres.

In no instance thus far have we found any indication of the spherical forms and pitted polyhedral matrix in species yielding rods, or *vice versa*. This suggests that the virus diseases of caterpillars that produce crystal-like polyhedral inclusions may fall into at least two different groups. That exhibiting the spherical forms and typified by the disease of the cream spot tiger moth caterpillar has not previously been described.

We are continuing these combined studies of the virus polyhedra from a number of related species of caterpillars both in section and after disintegration. A more detailed report of the results already obtained will be published elsewhere.

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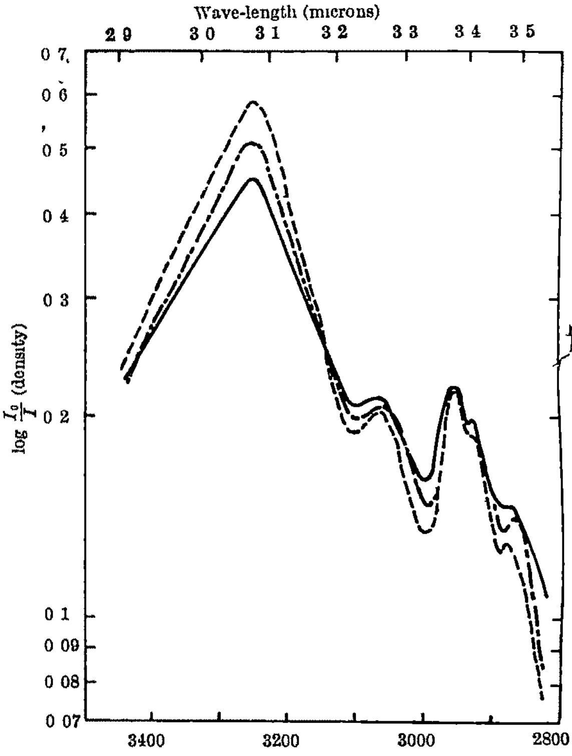
## Infra-Red Spectra of Films of Native and Denatured Pepsin

WE report here some observations on the infra-red absorption of films prepared by drying native, denatured, and regenerated pepsin solutions. On thermodynamic grounds[1] the alkali denaturation of pepsin molecules unrestricted in space (dilute aqueous solution) would be expected to involve the breaking of a large number of intra-molecular hydrogen bonds. As yet, direct evidence as to the formation of new intermolecular hydrogen bonds between uncoiled molecules is lacking. Differences in the infra-red absorption spectra of native and denatured pepsin in the range of hydrogen-bonding frequencies can, with reasonable assurance, be assumed to represent evidence for overall changes in hydrogen bonding. The infra-red spectra of films of pepsin and other enzymes measured in the wave-length region 2–15 microns[2,3] show, in addition to the strong bands around 3, 6 and 6.5 microns always obtained with proteins and polypeptides, several less intense absorption bands in both the 3-micron region and at wave-lengths longer than 6.6 microns. In this communication we are concerned only with the region 3,400–2,800 cm.$^{-1}$ (2.9–3.6 microns), in which the spectral measurements were made using calcium fluoride and lithium fluoride prisms, since this is a region of absorption by hydrogen-bonding frequencies.

Crystalline pepsin from two commercial sources (Armour and Worthington) was used in the preparation of native, denatured, and regenerated pepsin solutions. 300 mgm. of each of the crystalline pepsin preparations was dissolved in 5.0 ml. water acidified to *p*H 4.5 with dilute hydrochloric acid, and dialysed against water acidified to *p*H 4.5 for 24 hr. at + 2° C. Following dialysis, the pepsin solutions were made up to 25 ml. volume, and again adjusted to *p*H 4.5. Three 5.0-ml. aliquots of each was placed in three stoppered Erlenmeyer flasks and allowed to come to equilibrium at room temperature. One aliquot was then brought to *p*H 8.5 by addition of a known amount of alkali through a capillary, and kept at this *p*H for 8 hr. at room temperature. At the end of this period it was brought to *p*H 4.5 and the denaturation was confirmed by testing for loss of enzymatic activity.

The second aliquot was submitted to treatment identical with the first, but after standing at *p*H 8.5 at room temperature for 4 hr., it was adjusted to *p*H 7.5 with acid, then gradually brought to *p*H 6.8 over a period of 4 hr., by adding minute quantities of acid through a capillary pipette. The regeneration was confirmed by testing for reappearance of enzymatic activity. Finally, the solution was adjusted to *p*H 4.5 before preparation of the film. The third aliquot was kept at *p*H 4.5 for 8 hr., then a known



Infra-red spectra of films of pepsin adjusted to same density at 2,960 cm.$^{-1}$

————, Film from native pepsin solution, — — — —, film from regenerated pepsin solution, – – – – – –, film from denatured pepsin solution amount of salt was added to duplicate the calculated amount of salt formed in the two other aliquots in the course of adjustment of $pH$ to 8 5 and then back to $pH$ 4 5 This third aliquot was used as the native pepsin sample in each case, since enzymatic activity proved to be intact

Enzymatic activity was tested by incubating 1 0 ml of each of the three aliquots at the end of the experiment with 2 0 ml of 2 per cent denatured bovine albumin as the substrate (heat-denatured at 83° C for 10 min ) and 0 5 ml of 0 09 $N$ hydrochloric acid Proteolytic activity was determined (*a*) by formol titration, and (*b*) by measurement of the decrease of turbidity with increasing enzymatic hydrolysis of the substrate In this manner 40 per cent activity was found in the regenerated Armour pepsin and 25 per cent in the regenerated Worthington pepsin, assuming the values obtained for the native pepsin to be 100 per cent and the denatured, zero These solutions of native, denatured and regenerated pepsin prepared in identical manner from two different sources of crystalline pepsin and all adjusted to the same final $pH$, were used in the preparation of films for infra-red absorption studies

Typical spectral data are reproduced herewith Since the films were all prepared by evaporating or casting a few drops of the pepsin solutions on silver chloride disks and then drying in a vacuum desiccator over phosphorus pentoxide at 3° C similar to the way previously described for nucleic acids[4], the thickness of the films varied somewhat from preparation to preparation This variation in thickness has been compensated for by making the assumptions that the number of C—H bonds per molecule are constant and also that the 2,960-cm $^{-1}$ C—H stretching frequency obeys Beer's law independently of whether the protein is in a native or denatured state If one makes these two assumptions, the first of which is probably exactly valid and the second approximately valid over a relatively limited thickness range, then one may adjust the intensity of the rest of the spectra to fit the use of the 2,960-cm $^{-1}$ absorption band as an internal standard[5] This procedure was followed with several different pepsin preparations by plotting density on log paper and reducing to a common density at 2,960 cm $^{-1}$ In each case it was noted that the relative absorption of the film obtained from denatured pepsin solutions was higher in the 3,260-cm $^{-1}$ region than that of films cast from native pepsin solutions, while the absorption of the films obtained from the regenerated pepsin lay always at some intermediate value In our experiments the (adjusted) absorption differences in the intensity of the 3,260 cm $^{-1}$ band were of the order of 0 05–0 25 density units

It seems established, mainly by the careful studies of Sutherland and his co-workers on a variety of simple amides as well as on certain peptides and proteins[6,7], that the 3,260-cm $^{-1}$ band is associated with a hydrogen-bonded N—H frequency Our measurements show an increase in the intensity of this frequency as the percentage of residual native pepsin decreases, thus indicating an increase (in the denatured state) in the intensity or number of the bonds with which this frequency is associated In denatured protein films, the probability of orientation of the uncoiled pepsin molecule, and the institution of the mesomorphic state through intermolecular bonding along adjacent uncoiled molecules, are greatly enhanced This appears to be supported by our results.

We are indebted to Dr R C Lord for interesting discussions on this subject, and to Dr V Z Williams for the use of a lithium fluoride prism

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## Alteration of Collagen Structure by Irradiation with Electrons

In endeavouring to induce shrinkage in collagen by irradiation with electrons, structural alterations in the material were determined from the low-angle X-ray diffraction patterns of samples which had been exposed in the beam of an electron accelerator Previous experiments have shown that, when collagen is permitted to shrink hydrothermally, the average intensity of the low-angle diffraction pattern decreases with the degree to which the sample has been allowed to shrink The elongation at which this pattern disappears is dependent upon the temperature at which the shrinkage takes place Thus, the intensity of the low-angle diffraction pattern can be used as a means of determining the amount of structural damage brought about by electron irradiation

The electron beam used to irradiate the collagen samples was derived from a resonant cavity pulsed by a 10-cm , one-megawatt type 4*J*33 magnetron The magnetron was pulsed with one-microsecond pulses at 333 cycles per second, giving a 0 00033 duty factor With this duty factor, the average beam current output was about 1 2 microamp at a maximum energy of 0 63 MeV Spectrometer tests indicated that the beam energy was not monochromatic but possessed a maximum intensity of 0 3 MeV The rate at which the samples were irradiated was determined to be of the order of 2,000 r per sec This value was obtained by extrapolating Victoreen 'r' meter measurements to a distance of 1 5 cm from the window

Both wet and dry samples of untreated kangaroo tail tendon collagen were exposed to the electron beam for varying amounts of time All samples were held in a small clamp which could be mounted in the low-angle diffraction camera This held the fibres parallel and ensured that the X-ray beam would be directed at the same region of the fibres which had been exposed to electrons All samples were dried before their low-angle patterns were photographed The X-ray diffraction results are listed in the accompanying table

It was observed that wet samples which were not clamped curled toward the electron source after about

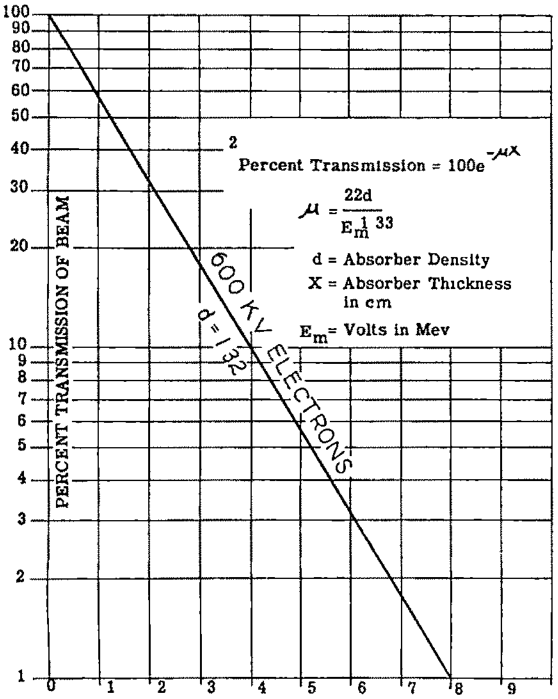
| Sample | Electron exposure (min.) | Integrated time pulses (sec.) | Diffraction pattern intensity | Estimated crystallinity* (per cent) |
|---|---|---|---|---|
| Dry collagen | none | | good | 100 |
| Wet collagen | 10 | 0.2 | faint | 30 |
| Wet collagen | 20 | 0.4 | very faint | 10 |
| Wet collagen | 45 | 0.9 | none | 0 |
| Dry collagen | 30 | 0.6 | medium | 50 |
| Dry collagen† | 30 | 0.6 | none | 0 |

* Based on 100 per cent = amount of crystallinity in dry untreated collagen.

† Soaked in water after electron exposure.

a 15-min. exposure. After the same amount of exposure, fibres of clamped wet samples showed a tendency to break, curl and shorten lengthwise. This curling of wet samples can be explained by the fact that maximum ionization occurs at one-third of the maximum distance penetrated by the beam in the irradiated sample[1]. Shrinkage is, therefore, initiated in the upper half, and uniform shrinkage of the entire fibre is never achieved because, by the time sufficient ionization has occurred at the lower surface, the upper section of the fibre has absorbed so much energy that gelatinization has taken place and the material dissolves. The absorption curve shown in the accompanying graph indicates that about 98 per cent of the electron beam is absorbed in penetrating collagen samples, which were 0.75 mm. in diameter. Attempts to measure the rise of temperature of the collagen during irradiation indicated that it was only a small fraction of a degree.

It is interesting to note that, in the dry sample, a 30-min. exposure to electrons produced no observable alterations in the physical appearance of the material other than a marked yellow discoloration, and the X-ray diffraction pattern showed evidence that a large percentage of crystallinity remained in the sample. Yet, when this sample was immersed in water for a few hours, most of the material dissolved and all that remained was a thin gelatinous film which exhibited only an amorphous low-angle diffraction pattern.



Absorption of electrons by dry collagen

The above findings may be of significance to those employing an electron microscope in the study of collagen. Although the electron energy in an electron microscope is considerably less than that used above, it may still be sufficient to cause appreciable changes in the specimen. Considering the minute cross-section of the electron microscope samples, any change which might be produced by electron radiation would occur practically instantaneously. It is possible that such an effect might introduce uncertainty in interpreting electron micrographs in terms of the true structure of collagen.

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## Effect of Neutron Irradiation on the Thermal Conductivity of a Quartz Crystal at Low Temperature

THE thermal conductivity of crystals is very structure-sensitive, particularly at low temperatures. In the case of dielectric crystals, this has been demonstrated by de Haas and Biermasz[1], who measured the effect of heat treatment on the conductivity of a quartz crystal in the liquid-hydrogen temperature region.

In the present experiments lattice defects, consisting of displaced atoms, have been produced in a quartz crystal by irradiation with fast neutrons in a pile, and we have measured the changes in conductivity after several successive periods of irradiation and after subsequent annealing. The extra thermal resistance is due to these displaced atoms and is not associated with any nuclear transformations which may be produced in small quantities during the irradiation.

The temperature-range of the measurements, 2°–90° K., is covered more fully than has been done before in heat conductivity measurements, and the curves shown in Fig. 1 each comprise 15 to 25 measured points.

The theory of the thermal conductivity of dielectric crystals was developed by Debye[2], Peierls[3], Pomeranchuk[4] and Casimir[5]. At low temperatures the thermal resistance can be regarded, to a first approximation, as being composed additively of the resistances due to the following processes, which are responsible for the scattering of phonons (lattice waves): (1) boundary scattering, which produces a resistance $W_B \propto L^{-1}\,T^{-3}$, where $T$ is the absolute temperature and $L$ is the external dimension of the crystal[5]; (2) 'umklapp' processes, which produce a resistance $W_U \propto T^{-2}\exp(-\theta/2T)$, where $\theta$ is the Debye temperature[3]; (3) scattering by various disorders, such as lattice defects which produce a resistance $W_D \propto \varepsilon T^{n}$, where $\varepsilon$ is the defect concentration and $n$ is a constant which never exceeds $+1$.

One of us[6] has combined the rigorous method of Peierls with the approach of Pomeranchuk and has applied the theory to the conductivity of crystals and glasses. In the case of quartz crystals, an analysis on the basis of the present theory of the results of de Haas and Biermasz[1] and of the present experiments shows that $W_B$ is the chief factor determining the resistance below 10° K. and $W_U$ the chief factor above that temperature. $W_D$ is only an appreciable fraction of the total resistance in the neighbourhood of 10° K. The resistance is mainly determined by the mean free path of the transverse waves.

In the case of quartz glass, this theory shows that the conductivity at high temperatures is mainly due to the transverse waves and is proportional to the specific heat (as pointed out by Kittel[7]). At low temperatures, the contribution from longitudinal waves predominates and gives rise to a component which is proportional to $T$ at the lowest temperatures, reaches a maximum and then falls off. The combination of these two components produces the conductivity, as measured before by one of us[8], and shown in Fig. 1.

It can be seen from Fig. 1 that, with increasing irradiation, there is a gradual transition in the form of the temperature-dependence of conductivity from that of the original crystal to that of the glass. This can be explained as follows. Fast neutrons produce cascades of displaced atoms, some of which are clustered together in small regions, while others are separated by many atomic diameters from neighbouring defects. After the first irradiation the crystal shows a resistance additional to the normal resistance which, above 15° K., can be interpreted as the resistance due to the numerous single lattice defects. Below 15° K., however, the extra resistance is in the nature of a boundary resistance, with a value of $L$ of the order of $10^{-2}$ cm. This can be interpreted as due to the clusters scattering phonons independently of their frequency, giving an apparent size-resistance with $1/L \simeq \sigma N$, where $N$ is the number of clusters in unit volume and $\sigma$ is the cluster cross-section.

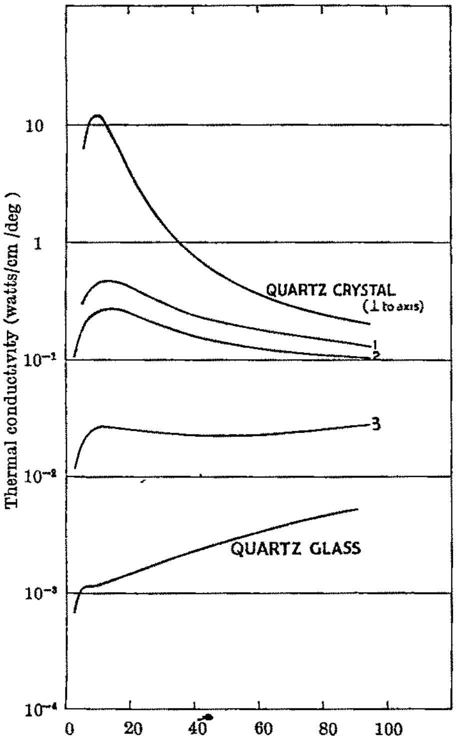

Fig. 1. Thermal conductivity of quartz crystal, irradiated quartz crystal and quartz glass. Cumulative irradiation doses: (1) 1 unit; (2) 2·4 units; (3) 19 units

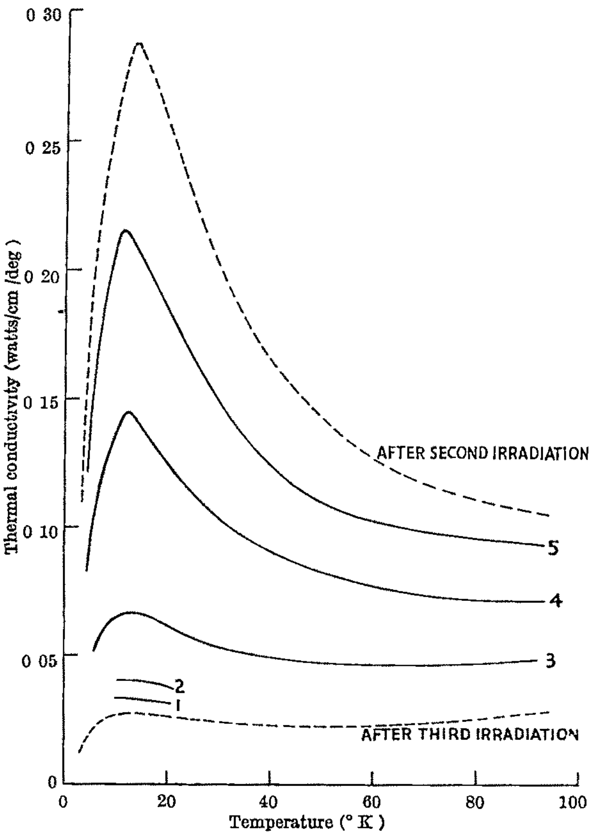

Fig. 2. Thermal conductivity of irradiated quartz crystal after successive annealings: (1) 300° C. for 8 hr.; (2) 400° C. for 6 hr.; (3) 510° C. for 6 hr.; (4) 565° C. for 6 hr.; (5) 540° C. for 60 hr.

After prolonged irradiation the number of single defects is so large that there is interference between neighbouring defects, and the temperature-dependence of the defect resistance gradually changes to the case of glass, that is, the scattering by defects becomes less dependent on frequency. Also, at low temperatures the longitudinal component of conductivity becomes appreciable, compared with the transverse component, resulting in a peak at 10° K. We can regard the irradiated crystal as a 'dilute glass'.

The cumulative irradiation doses after the three periods of irradiation are in the ratios 1 : 2·4 : 19, and the induced resistances at the lower temperatures are in roughly these ratios. During the first irradiation the thermal neutron dose was $1{\cdot}8 \times 10^{18}$ per square cm.

The effect of annealing the crystal, at various temperatures, after the last irradiation, is being studied. The conductivities after annealing are shown in Fig. 2. So far, the crystal has not been heated above 573° C., the transition temperature from α- to β-quartz. The shape of the conductivity-temperature curve after the last annealing is slightly different from that after the second irradiation and suggests that a smaller percentage of defects are now clustered together.

More details of these experiments and of their interpretation will be given elsewhere

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Aug 31

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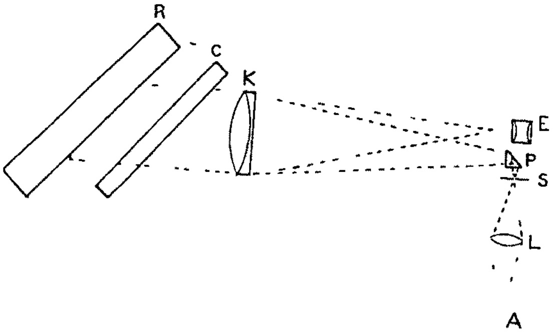
## Use of Diffraction Gratings Ruled on Cylinders

I have recently described[1] a method of ruling diffraction gratings on cylinders by a method which gives results substantially free from the periodic errors otherwise difficult to avoid, and by coating such cylinders with a plastic pellicle, which is afterwards removed, it is possible to prepare flat gratings in hardened gelatine on optically flat glass

I have recently found that it is possible to use these ruled cylinders as the dispersing element in a spectroscope When a flat grating is used, the collimating lens (or a reflector) ensures that the rays shall fall on the grating at the same angle In using the cylinder grating as a dispersing element, this condition is fulfilled by the use of a cylindrical lens placed obliquely in the beam of parallel rays from the collimating lens, the axis of the cylinder grating being set accurately parallel to the axis of the cylindrical lens and at right-angles to the plane of the slit A simple disposition of the optical parts involved, which illustrates the method, is shown in the accompanying diagram In this the Littrow arrangement is used, the same lens being used as collimator and telescope and the light from the slit being directed towards the collimating lens by means of a small right-angle reflecting prism

Observations of the image are made with an eyepiece either just above or below or to one side of the right-angle prism Light from the source $A$ is brought to a focus on the slit $S$ by means of the condensing lens $L$ and is reflected towards the collimating lens $K$ by means of the prism $P$ The rays then fall on the cylindrical lens $C$, the axis of which is parallel to the axis of the ruled cylinder $R$ The distance from $C$ to $R$ is adjusted so that rays proceeding from a point in the centre of the slit would be focused as a line on the axis of the ruled cylinder $R$ The axis of the cylinder $R$ is disposed, in relation to the optic axis of the collimator, in such a way that the rays fall on the ruled cylinder at right-angles to the individual flat facets of the cuts made by the diamond in ruling the grating, the order of the spectrum observed in the eyepiece $E$ being thus that order into which the greater part of the energy is thrown It will be seen that the rays fall on the ruled cylinder at the same angle



This arrangement has been tried with a cylinder grating one inch in diameter ruled with 4,000 lines to the inch, and excellent definition was obtained in the fourth order, which showed a fairly good 'blaze' A similar arrangement, in which lenses are replaced by reflectors, follows on obvious lines and should be applicable to instruments designed for use in the infra-red The resolving power and dispersion can be evaluated in precisely the same manner as if a plane grating were used, but whereas in the case of a plane grating the light-gathering power is proportional to the area of the ruled surface, with the method described above the light-gathering power is independent of the diameter of the ruled cylinder With flat gratings of very large ruled area, the total distance travelled by the ruling diamond may be so great as to impair the diamond through wear before the whole area can be covered, but with the cylinder grating this difficulty should be greatly reduced It should also be possible to bore cylinder gratings axially and so maintain a constant temperature by circulation of water

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[1] *Proc Roy Soc*, A, **201**, 187 (1950).

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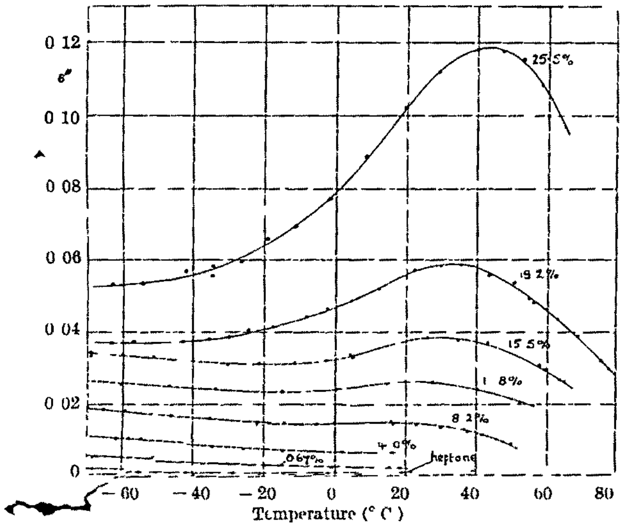
## Dielectric Relaxation of Alcohol–Heptane Mixtures

It is well known[1] that pure alcohols exhibit a large dielectric absorption at radio frequencies, together with a very much smaller absorption in the centimetre region For measurements at a fixed wave-length of 10 cm, this corresponds to the occurrence of loss peaks at temperatures of the order of + 100° C and − 100° C respectively In practice, the low-temperature loss peak thus found would be largely obscured by the loss at high temperatures, but this is no longer the case when the alcohol is dissolved in a non-polar solvent

A 10-cm $H_{01}$ resonator has been used to measure the dielectric absorption of solutions of *n*-amyl alcohol in heptane Curves are given in the accompanying graph showing the variation of $\varepsilon''$ with temperature for a number of concentrations between 0 6 and 25 mol per cent The curves show how the 'low-frequency' loss maximum falls rapidly with dilution, such that at the intermediate concentration of 15 5 per cent the losses due to the separate relaxation mechanisms are approximately equal On the other hand, the loss at − 70° C, which for these concentrations is almost entirely due to the high-frequency mechanism, falls proportionately with concentration At very low concentrations (less than



Dilute solutions of *n*-amyl alcohol in heptane
Concentrations in moles per cent

1 per cent) the 'low-frequency' loss disappears and only the 'high-frequency' loss remains

Similar behaviour has been found for mixtures of *n*-butyl alcohol and *n*-propyl alcohol in heptane It is hoped to publish these curves, together with a more detailed consideration of the results, in the near future

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July 11

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## Structure of a Deformed Metallic Grain

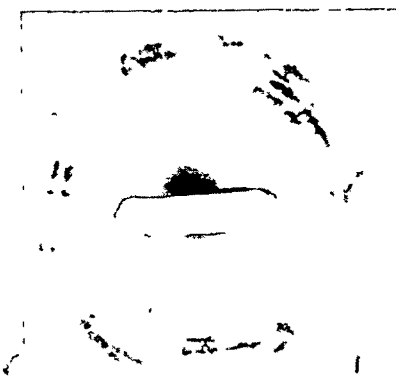
A NUMBER of years ago, Wood[1] suggested that the circumferential spreading of the sharp X-ray diffraction spots from annealed grains into continuous arcs along the Debye circle on deformation could be best accounted for by supposing that the grains break down into a number of fragments oriented at small angles to each other Experiments on the deformation of polycrystalline aluminium at elevated temperatures under creep conditions have confirmed that the individual grains break down into more or less perfect crystalline elements, the degree of perfection and size of which increase with increasing temperature and decreasing strain-rate[2,3] It appears that the continuity of the Debye arcs from aluminium deformed rapidly at room temperature is due to the smallness of the fragment size Further direct confirmation of this view has been obtained recently by a micro-beam X-ray technique[4]

Cahn[5] has suggested that, at least in bent single crystals of zinc, the lattice is bent continuously by the deformation and that, on heating, the crystal breaks up into a number of distinct crystalline elements Some previous research on the deformation and recovery of high-purity polycrystalline aluminium, however, had suggested that the discrete structure observed after recovery was present already in the deformed state[6] This led to similar experiments being performed on high-purity polycrystalline zinc The purpose of this note is to show that zinc confirms the fragmentation theory in a rather spectacular manner

The experiments consisted in lightly (up to 3 5 per cent) deforming coarse-grained electro-polished specimens in tension at various temperatures and examining them both microscopically and by the usual X-ray back-reflexion method

Fig 1 shows the diffraction pattern from a specimen stretched 3 1 per cent at 21° C The X-ray pattern from the same area in the original annealed condition consisted of five sharp spots, each from individual grains Since each arc is very discontinuous, it appears that each grain has broken down into a number of quite large fragments tilted relatively to each other Microscopic examination also revealed that a number of grains manifested an inner structure, as shown by sharp changes in direction of the slip lines

After elongating a similar specimen the same amount at 200° C, the diffraction pattern shown in Fig 2 was obtained, each arc exhibiting a more discrete structure than in the previous case The corresponding photomicrograph, Fig 3, illustrates the typical surface appearance of the specimen Before deformation, the grain showed no trace of internal structures After deformation, as shown, the grain in the lower centre of photograph manifests a most marked inner structure and no trace of slip The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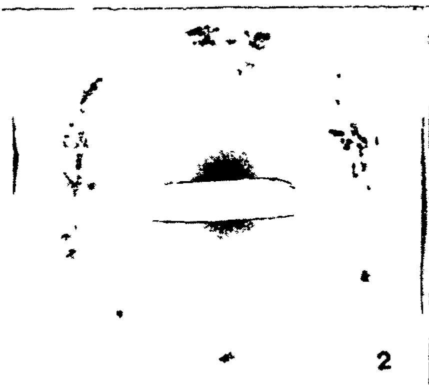
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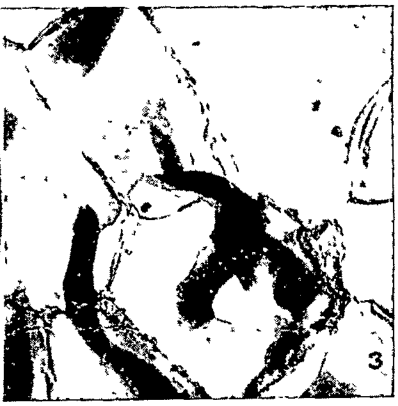
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Fig 1 Diffraction pattern from polycrystalline zinc elongated 3 1 per cent at 21° C
Fig 2 Diffraction pattern from polycrystalline zinc elongated 3 1 per cent at 200° C
Fig 3 Photomicrograph from the area corresponding to Fig 2 × 75

neighbouring grains show slip and also traces of a sub-structure. The original grain boundaries are characterized by their 'thickening' due to the deformation. It was demonstrated that the effect was not superficial by electropolishing the surface and re-etching, which brought out the original grain boundaries and the network of sub-boundaries within the grains corresponding with the boundaries of the inner structural elements.

On the basis of these results, it may be concluded that, upon the deformation of polycrystalline zinc, the grains break down into a number of fragments, the degree of perfection, and probably the size, of which increase with increasing temperature of deformation.

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July 31.

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## Thermal Radiation and Chemiluminescence from Explosion Flame Gases

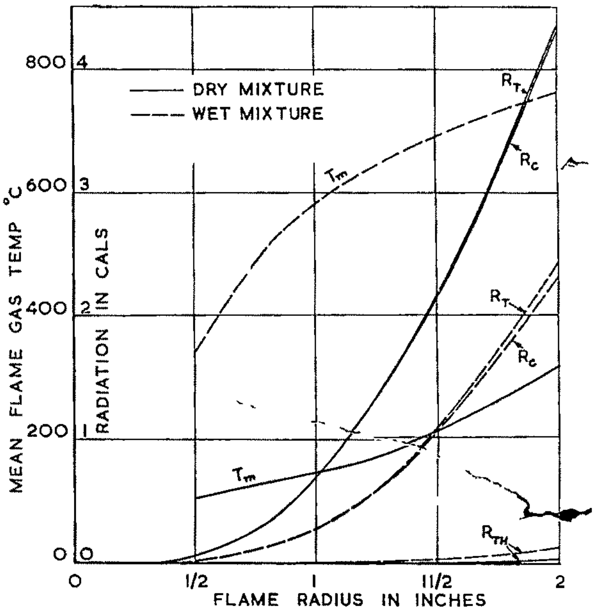
The radiation emitted during explosions of gaseous inflammable mixtures has been studied by several workers, notably David[1] and Garner[2], yet few data exist nor has finality been reached in deciding whether the radiation is purely thermal in origin or whether the phenomenon of chemiluminescence plays a part. In relation to carbon monoxide – oxygen explosions, Garner concluded that the radiation was partly of chemiluminescent origin, but his method precluded the quantitative assessment of the relative importance of each, nor has his conclusion been everywhere accepted[3].

We have recently undertaken a quantitative study of the radiation emitted from explosions and have been able to show that chemiluminescence plays a major part in the case of carbon monoxide – air explosions.

The explosion vessel used was a steel cylinder 5 in. in diameter and 7 ft. in length, one end being hemispherical and the other open to atmosphere (during explosion only) in order to maintain constant (atmospheric) pressure throughout the explosion. Ignition was effected by a high-tension condenser discharge across a spark gap at the centre of the hemispherical end. The flame movement during the early stages of the explosion, while the flame retains a very nearly spherical front, was recorded photographically using a lens system described elsewhere[4].

Special resistance thermometers, recording through an A.C. bridge on a cathode ray oscillograph, were used to measure the flame-gas temperatures at various radii from the source of ignition, corrections being applied as previously described[5].

The radiation bolometer used was of special form, consisting of 0.001-in. diameter copper wire wound non-inductively in the form of a small cone and held in an ebonite holder. The bolometer was mounted behind a fluorite window in the wall of the tube so as to view the whole spherical flame during the early stages of explosion. The change of resistance of the bolometer was recorded on the cathode ray oscillograph simultaneously with the flame-temperature traces. With the direct calibration of the bolometer and the measured transmission efficiency of the fluorite window, the radiation received by the bolometer could be computed, and from the known solid angle subtended by the bolometer, the total radiation emitted by the growing ball of flame could be calculated at any instant.



After the flame had travelled down the tube to the open end, the reaction was shown to be completed in the flame gases near the centre of ignition by using catalytically active resistance elements[6]. The radiation then received by the bolometer from the hot flame gases must have been of purely thermal origin. The amount of this thermal radiation emitted per unit quantity of the products of combustion was computed from the geometry of the tube and bolometer for various mean gas temperatures during cooling. From these values the thermal radiation emitted by the expanding spherical flame up to a flame radius of 2 in. could be estimated. The difference between these estimates of the thermal radiation and the measured total radiation must be ascribed to chemiluminescence.

Typical results for a 45 per cent carbon monoxide + 55 per cent air mixture (*a*) when carefully dried and (*b*) when containing 0.25 per cent water vapour are shown in the accompanying graph. Curves $R_T$ represent total radiation, curves $R_{Th}$ the thermal radiation and those marked $R_C$ give the chemiluminescent radiation. The curves $T_m$ show the mean flame gas temperatures obtained by integrating the temperature-distribution curves. These temperatures are astonishingly low, as previously foreshadowed[7], and indicate a very deep reaction zone exceeding 2 in. in depth. By virtue of these low gas temperatures, the thermal radiation is a very small proportion of the total radiation emitted. This completely confirms Garner's conclusion that chemiluminescence does occur in the reaction zone.

In both wet and dry mixture explosions, the chemiluminescent radiation at all flame radii represreaction, although of enzymatic nature, is slow and it has not been possible yet to prepare pure $A_3$ or $P_3$ Chemical analyses of the reaction mixtures show that $A_3$ and $P_3$ do not contain phosphorus This fact, and the failure of the prostate enzyme to remove the second phosphorus of $A_1$ and $P_1$, indicate a difference in the chemical nature of the two phosphorus-containing groups of these proteins

In conclusion, it should be pointed out that only three properties, namely, electrophoretic mobility, crystal form and phosphorus content, have been used to identify the products of mild enzymatic degradation of ovalbumin Although chemical differences other than the phosphorus content may exist between $A_1$, $A_2$ and $A_3$ and between $P_1$, $P_2$ and $P_3$, it is probable that the mobility increments are largely due to the loss of the charged phosphate groups Moreover, additional confirmation that the $P_2$ obtained by dephosphorylation of $P_1$ is identical with that obtained by proteolysis of $A_2$ would be of interest in this connexion

I wish to express my thanks to Dr L G Longsworth for help in preparing this manuscript

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Rockefeller Institute for Medical Research,
New York June 24

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## Protein Activation of Streptolysin 'O'

MANY studies have been made of streptococcal hæmolysins Todd[1] demonstrated essential differences between the '*O*' and '*S*' forms of streptolysin Herbert and Todd[2] made a more exhaustive study of streptolysin '*O*' and characterized it as a protein capable of hæmolysing red cells, only, however, after activation with —SH-containing reducing agents

During experiments involving the use of certain streptococcal preparations and albumen and globulin fractions of serum, it was observed that rabbit red-cell suspensions were hæmolysed in the presence of mixtures of the streptococcal preparation and serum albumin

Streptolysin '*O*' prepared in Todd–Hewitt broth[3] and partially purified by Herbert and Todd's[2] method was found to be activated not only by —SH-containing reducing agents such as thioglycollic acid, cysteine, etc, but also by serum albumin

Albumin fractions separated from serum by 50 per cent saturation with ammonium sulphate consistently showed an activating effect when allowed to stand at room temperature with inactive streptolysin '*O*' The fractions were dialysed before testing, to remove ammonium sulphate, and were made isotonic by the addition of sodium chloride, their volumes being corrected to that of the original volume of serum used for precipitation The effect of these samples upon inactive streptolysin '*O*' was determined by mixing 0 5-ml volumes of the fraction under test with varying doses of previously standardized inactive lysin in equal volumes The mixtures were allowed to stand five to ten minutes at room temperature before the addition of 0 5 ml of 3 per cent washed rabbit red-cell suspension Buffer-saline mixture at *p*H 6 6 was used as diluent Controls of inactivated lysin and lysin activated with sodium thioglycollate were included with each series of tests Hæmolysis was observed after one hour in the water-bath at 37° C

Albumin fractions prepared from human, bovine (bovine crystalline albumin Amour and Co), horse and rabbit serum all showed varying though definite activation of streptolysin '*O*' The intact sera and the globulins of these species, with the exception of one sample of rabbit globulin, were without effect Two samples of ovalbumin and a muscle protein solution were also without effect If iodoacetate was added to the albumin – streptolysin mixtures, activation was either abolished or markedly reduced

Herbert and Todd[2] suggest that streptolysin '*O*' contains disulphide linkages which can be reversibly reduced to sulphydryl groups, the —S—S— form being hæmolytically inactive whereas the —SH form is active An interpretation of the activation of streptolysin '*O*' by reducing agents having free —SH groups has been made on this basis[2]

The activation of streptolysin '*O*' by s
albumin is most probably due to readily avai
—SH groups in the latter, since such activation
prevented by iodoacetate Anson[4] and Olcott
Fraenkel-Conrat[5], in reviews of properties of pro
groups, point out that the reactivity of —SH groups o
proteins varies with the protein and upon the amou
of denaturation it has undergone The inability
whole serum and the globulin fractions to acti
streptolysin '*O*' might be explained on this b
however, the presence of small amounts of
streptolysin '*O*' found in the globulin of even 'no
sera provides an alternative explanation

G S TUR

Northwestern University,
Rheumatic Fever Research Institute,
Chicago, Illinois June 15

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## Biological Oxidation of

Lees and Quastel[1] describe
apparatus in which a liquid c
tinuously through a column of
of maximum aeration The
by Audus[2] has been used in th
on the biological oxidation

*Biological oxidation of di*
columns of air-dried, cru
*p*H 3 0 were perfused
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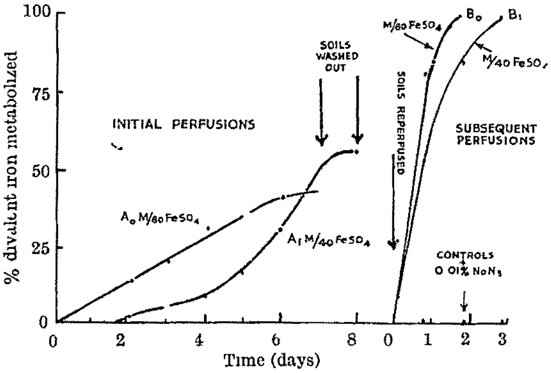


Fig 1 Effect of divalent iron concentration on its metabolism in normal air-dried soils, and the influence of sodium azide on this metabolism
($A$) 20 gm soil perfused with 200 ml ferrous sulphate sol $A_0$ $M/80$ FeSO$_4$, $A_1$ $M/40$ FeSO$_4$ (azide controls deducted)
($B$) Divalent iron metabolism in same soils on subsequent perfusion

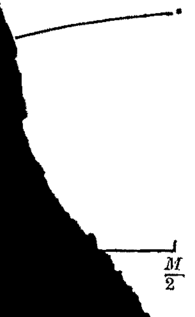
isms in the soil, in other soils, after an initial lag-
phase (where no divalent iron is metabolized), the
oncentration of ferrous cations afterwards falls at
n increasing rate This lag-phase is variable and de-
pends on the nature of the soil under investigation

It also appears that the initial concentration of
he divalent iron perfused may influence the lag-phase
fore oxidation takes place (see Fig 1, $A$) This lag-
se of the ferrous iron oxidizing micro-organisms,
llowed by a subsequent oxidation of the cation,
mably by the development of micro-organisms
are adapted to metabolize this initial high iron
ntration Investigations into these phenomena
published later

fter an initial perfusion, the soil is washed
stilled water and re-perfused with a fresh
f ferrous salt, no lag phase is observed, and
ferrous cation disappearance from the per-
tant (Fig 1, $B$)

l may be compared with an enzyme
us iron metabolism, and the influence
bolites on this system can be readily

s iron is oxidized to trivalent iron
an enriched soil the base-exchange
already saturated with trivalent
hed soil is perfused with divalent
that the fall in ferrous iron
perfusate is equal to the rise
ric ions



of oxygen

Table 1

| 20 gm soil (enriched) | Fe++ present/ml perfusate | Fe+++ present/ml perfusate |
|---|---|---|
| (1) perfused 200 ml FeSO$_4$ ($M/80$) | 600 $\mu$gm | 0 |
| (2) after 24 hr | 50 ,, | 550 $\mu$gm |

*Effects of a biological poison on ferrous oxidation* A cell poison such as sodium azide, when added at a low concentration to a soil perfusate containing ferrous sulphate, will completely inhibit all biological ferrous oxidation (Fig 1 and Table 2)

Table 2

| 20 gm soil (enriched) | Fe++ metabolized 24 hr /ml |
|---|---|
| ($a$) perfused 200 ml $M/80$ FeSO$_4$ | 550 $\mu$gm |
| ($b$) $M/80$ FeSO$_4$ + 0 01 per cent azide | 0 |

*Oxygen uptake studies of enriched soils* It has been found that the enriched soils described will retain their enriched nature when air-dried and stored at 0° C These soils may be studied using a modified Warburg technique (unpublished) developed by Quastel and his colleagues at the Agricultural Research Council Unit of Soil Metabolism

It can be shown that rates of oxygen uptake by an enriched soil following the addition of a divalent iron salt are dependent on the concentration of the divalent iron present (see Fig 2) This technique also readily shows the influence of poisons on the enzyme systems which are activated by the divalent iron compounds

Table 3 shows the inhibitory influence of three well-known enzyme poisons, sodium azide, mercuric chloride and iodoacetic acid, on oxygen uptake

Table 3

| Metabolite added to 4 gm enriched soil | Oxygen uptake ($\mu$l /gm soil/hr ) | % Inhibition |
|---|---|---|
| *Expt* 1 | | |
| (i) 1 5 ml $M/34$ FeSO$_4$ | 15 75 | — |
| (ii) 1 5 ml $M/34$ FeSO$_4$ + 0 01 per cent sodium azide | 2 73 | 82 6 |
| *Expt* 2 | | |
| (i) 1 5 ml $M/20$ FeSO$_4$ | 11 25 | — |
| (ii) 1 5 ml $M/20$ FeSO$_4$ + 0 1 per cent iodoacetic acid | 2 25 | 80 0 |
| (iii) 1 5 ml $M/20$ FeSO$_4$ + 0 1 per cent mercuric chloride | 1 95 | 82 6 |

It is hoped later to apply the methods to an examination of biological aspects of the problems of the availability of iron in soils to plants

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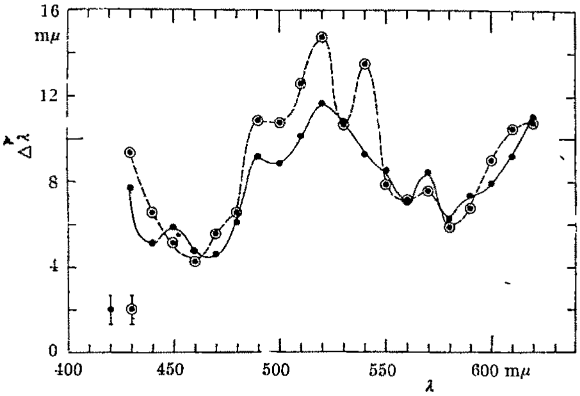
## Foveal Hue Discrimination in the Presence of a White Surround

IN the course of an investigation of hue discrimination in the para-central parts of the human eye[1], this property was measured also in the fovea at an intensity level of 0 95 e f c The test field was bipartite, subtending an angle of 50′ at the eye, and surrounded by a white field (6°), the latter was separated from the test field by a black line The results are shown in the accompanying figure, Δλ, the least perceptible difference, being plotted against λ, the short-wave limit of each step, each point represents the mean of five readings The high-brightness data for the



○—○—, with surrounding ●—●—, without surrounding

author's fovea are characteristic of an observer with normal colour vision and agree with Pitt and Wright's [illegible]² At low brightnesses, however, there seems to [illegible] suggestion of reduced colour vision, a finding [illegible] confirms Thomson and Trezona's results³ [illegible] is a subsidiary optimum at 0 53 μ which does [illegible] em to have been reported by any other worker [illegible] t is represented by only one point, a similar [illegible] y optimum has been observed in other sets [illegible] ns each Its exact position seems to be very [illegible] to brightness at an intensity of 9 5 e f c, t[illegible] pessima at 0 52 and 0 54 μ are fused

[illegible]e way in which the optimum at 0 53 μ can be made to disappear at low brightnesses is by removing the white surround The data for the experiment carried out in this condition are presented on the same graph, they were obtained concurrently, hence day-to-day variations should be reflected in both to the same extent Representative samples of the respective standard errors of the mean are shown in the bottom left-hand corner The two curves are evidently similar Two subsidiary pessima at 0 49 μ and 0 57 μ are reproduced in both curves, and there is evidence for the belief that the latter in particular is not spurious It will also be noticed that the familiar double bend at 0 44–0 45 μ is found only in the data obtained without the surround

None of the existing hypotheses describing colour vision can account for these facts Wright² found [illegible]at preliminary low brightness-adaptation to white [illegible]ght effected an improvement in hue-discrimination [illegible]t 0 58 μ, a deterioration with subsequent slight improvement at 0 53 μ, and a progressive deterioration at 0 494 μ In the present case, however, the adaptation was simultaneous and outside the test field It is difficult to escape the conclusion that the surround has improved differentiation by partly light-adapting the eye this leads to the conclusion that linking of foveal receptor paths can take place under certain conditions This idea has been put forward also by Lythgoe⁴ largely as a result of researches on the variation of visual acuity with brightness If visual acuity is governed by the interaction of the receptor-paths, colour vision would be expected to behave in a similar manner unless each 'visual acuity-path' represents a 'colour-unit' containing different colour mechanisms

The interpretation of the pessimum at 0 52 μ is difficult Although Granit⁵ has found modulators occupying this spectral position in the eyes of the cat and the snake, and Hartridge⁶ reports that he has found a fixation point for this wave-length, the shift of this peak in paracentral parts of the eye, on reducing the brightness, leads to the tentative suggestion that it may be due to a mixture of visual purple and indicator yellow Dartnall⁷ has given the theory of such an internal filter to account for the photopic luminosity curve and the Purkinje shift According to his analysis, the peak of the absorption of visual purple is displaced to longer wave-lengths at higher brightnesses While the present results do not clash with this idea, the fact that the presence and absence of a surround should produce different hue-discrimination curves makes it evident that an explanation must be given on the basis of a nervous mechanism

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July 17

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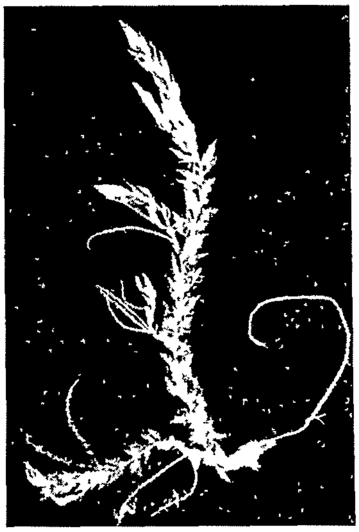
## Occurrence of *Asparagopsis armata* Harv. on the Coast of Cornwall

THE occurrence of *Falkenbergia* on a shore of
Lundy Isle was reported last year by Harvey and
Drew¹, and since then I have received specimens
this inconspicuous alga from Miss M de Val
collected in November 1939 from near Gal
Harbour and in July 1941 at Muigh Inis, Irel
as well as another from Miss S M Lodge from L
Ine, collected in July 1949 In addition, I m
have found *Falkenbergia* cast ashore in Augus
this year at Falmouth and also at Kennack
on the Lizard Peninsula It must be regarded,
fore, as a not uncommon component of the
marine flora Although well developed, the
plants were sterile, like all others examin

If J Feldmann and G Feldmann's²
that *Falkenbergia* is but a phase in the li
*Asparagopsis armata* Harv is correct, then
likely that the latter's appearance on the
coast would follow that of *Falkenbergia* T
indeed proved to be the case, and the freque
which *A armata* could be found on the shor
Lizard Peninsula in August of this year s
it is well established on this stretch of co
developed specimens were found at P
Polurrian Cove, Kynance Cove, Cove
well as at Kennack Sands, where t
ticularly numerous on August 9, 1950
In fact, it was the most common al
on that occasion Attached plants
but the shores mentioned were n
particularly good tides This is the
occurrence of *A armata* on the
although it has been reported
Ireland by de Valéra³ as havin
Inis in July 1941. De Valéra
growing *in situ* "on or in a
on the much exposed sides
rocks at extreme low wat



Piece of female plant of *Asparagopsis armata* Harv collected at Coverack Cove, Cornwall on August 4, 1950 (× ⅔)

was described by Harvey[4] from Australia and Tasmania originally, has gradually spread in Mediterranean and Atlantic European waters and has been known for the north-west seaboard of France since 1925 [5] Both *Falkenbergia rufolanosa* and *Asparagopsis armata* were abundant in the Bay of Concarneau and on the shores of the Isles of Glénan, in 1946 It is surprising, therefore, that it has not been found on the south-west coast of England sooner

The Cornish plants occurred as tufts tangled round ther algæ (often species of *Ulva*) and in one instance and feathers From the centre of the mass, free nches, one of which is shown in the photograph, ead out These are usually 4–6 in in length The tograph also shows the characteristic runner-like nches with reflexed 'barbs' These branches, which effective in propagating the plant vegetatively, particularly frequent and sometimes of considerength, the longest being about 4 in Among ants preserved, a number bear developing ps, but no spermatangial branches have been

KATHLEEN M DREW

ment of Cryptogamic Botany,
University of Manchester
Sept 28

C C, and Drew, K M, *Nature*, **164**, 542 (1949)
, J and Feldmann, G, *Ann Sci Nat Bot*, **11**, 3, 75 (1942)
M, *Irish Nat J*, **8**, 30 (1942)
H, *Trans Roy Irish Acad*, **23**, 554 (1855)
*C R Assoc fr pour l'avan des Sci*, 360 (1926)

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## d Photoperiodism in the Fruit Spider Mite (*Metatetranychus ulmi* Koch)

kson[1,2] on the oriental fruit moth ) and by Way, Hopkins and moth (*Diataraxia oleracea*) and ve directed attention recently ht (day-length) in controlling ome earlier work on insects at other events in the developmental cycle, such as the resumption of growth in certain tree-hole mosquitoes[4] and the appearance of sexual forms in aphids[5–7], were also determined by the duration of light Nevertheless, a photoperiodic response of this nature, serving to adjust the life-cycle to the seasons, may perhaps be of wider occurrence in arthropods than has been generally appreciated

The fruit tree red spider mite lays eggs of two distinct types The 'summer' eggs are laid on the leaves of the host plant (apple being the most important), whereas the 'winter' eggs, differing slightly in size and pigmentation, are deposited mainly on the bark 'Summer' eggs hatch in about eight days at 25° C On the other hand, large numbers of 'winter' (diapause) eggs, collected in mid-October before the first frosts, have been kept at this temperature for as long as one year without any hatch occurring

The egg-laying mites can be recognized as 'summer' or 'winter' females only by their eggs But this is a useful distinction, as under uniform conditions female lays only a single type of egg Experime which mites were reared on small apple se under controlled conditions have shown tha the photoperiod and temperature are implica the determination of the reproductive function This is illustrated in Table 1 First-generation larvæ that had emerged from winter eggs were here used as the starting material The numbers of winter and summer females produced in groups of ten individuals are recorded under 'w' and 's' respectively Illumination at the leaf surface was of the order of 100 foot-candles

Table 1

| Temperature (° C) | Photoperiod (hr per 24 hr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 8 | | 12 | | 16 | | 24 | |
| | w | s | w | s | w | s | w | s |
| 15 | 10 | 0 | 9 | 1 | 0 | 10 | 0 | 10 |
| 25 | 2 | 8 | 1 | 9 | 0 | 10 | 0 | 10 |

At 15° C, winter females develop when the daily photoperiod is 8 or 12 hr, and summer females when the photoperiod is 16 hr or longer Higher temperatures (for example, 25° C) partially eliminate this photoperiod effect

Inheritance seemingly plays no part in the de termination When subjected to the appropri conditions, winter female gives rise to winter fema in one generation, without the interpolation of summer generations, and cultures of mites maintained at 25° C in long (16-hr) days have to date produced twenty-five summer generations in unbroken succession

Dierick[8] has recently reported that winter eggs in diapause can be induced to hatch by dipping them in xylol Whatever light this observation may throw on the mechanism of diapause in the egg, there seems little doubt that in Nature cold is the responsible agency Table 2 shows some results of exposing winter eggs, collected in October, to temperatures of

Table 2

| Temperature (° C) | % hatch after days at 2–3° or 18° C | | | | |
|---|---|---|---|---|---|
| | 50 | 100 | 150 | 200 | 300 |
| 2–3 | 0 | 7 | 13 | 68 | 29 |
| 18 | 0 | 0 | 0 | 0 | 0 |

2–3° and 18° C for varying periods before returning them to 25° C for hatching At the lower temperature, diapause was almost completely eliminated in the surviving eggs after about two hundred days Temperatures of 5° and 9° C yielded very similar results, whereas no eggs hatched at 18° C

Recent work[9,10] has shown that in England the mites pass through five generations annually Hatching of the winter eggs usually begins in late April There follow two generations consisting of summer females only, two of both summer and winter females and [illegible] of winter females only The environmental [illegible]ies discussed above no doubt play a considerable [illegible] in governing the course of the life-cycle The [illegible] obligatory period of diapause delays hatching [illegible] there is foliage available for the young mites [illegible] is a further consequence, for the earliest de[illegible]ng mites of the first generation do not reach [illegible] sensitive to the photoperiod until mid-May, [illegible]he day-length is 15½ hr This timing, therefore, ensures that the first generation consists only of summer females Winter females begin to appear in appreciable numbers in August (day-length 15½–13¾ hr ) and become most abundant in September (day-length 12 hr by September 25)

Further work on the physiology of diapause in red spider mites is in progress An account will appear elsewhere

A D Lees

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July 12

[1] Dickson, R C , and Sanders, E , *J Econ Ent* , **38**, 605 (1945)
[2] Dickson, R C , *Ann Ent Soc Amer* , **42**, 511 (1949)
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## Factors Influencing Diapause in the European Red Mite

THE European red mite, *Paratetranychus pilosus* C and F , is a pest of considerable importance in the apple orchards of Tasmania In the course of a detailed investigation of the problem, preliminary studies were undertaken in the 1949–50 season for the factors influencing diapause

*P pilosus* overwinters in the egg stage The spring and early summer generations of female mites lay eggs which hatch within 5–14 days These summer eggs, which are pale green to orange in colour, are laid on the leaves of the host plant

In Tasmania from early February onwards successive generations contain an increasing proportion of females which lay overwintering eggs These eggs are deep red in colour and, unlike the summer eggs, are laid almost exclusively on the wood of the tree This change in the behaviour pattern of the females of the autumn generations was particularly noticeable in laboratory life-history studies when individual females were caged on apple leaves Whereas in the early generations the females laid freely on the leaf surface, those of the autumn generations preferred to oviposit on either the walls or cork tops of the cages A similar observation was made by Cagle[1], who met the needs of the females for a different oviposition site by placing small pieces of apple twig in the cages

Cottier[2] in New Zealand suggested that the laying of winter eggs was dependent on the available food supply, commencing earlier on heavily infested trees Although the influence of the food supply has not yet been studied in this laboratory, it is now apparent that there are other factors involved

At a constant temperature of 68° F , 205 larvæ were bred through to the adult stage and allowed to oviposit in small cages on excised apple leaves[3] under different day-lengths produced by means of artificial lights (25-watt tungsten globes producing approximately 12 foot-candles at the leaf surface)

The percentages of females laying overwintering eggs were as follows

| Hours of light | 0 hr | 6 hr | 12 hr | 18 hr | 24 hr |
|---|---|---|---|---|---|
| % females laying overwintering eggs | 92 | 92 | 100 | 40 | 12 |

Although these results are based on a relatively small number of females, it is apparent that the length of day had a marked influence on the development of the overwintering phase

These tests were conducted during early autumn when a proportion of the females in the laboratory life-history studies had already commenced to lay overwintering eggs By breeding mites under continuous light it was possible to obtain summer eggs until early winter, when apple foliage became unobtainable because of normal defoliation of the trees

In a further limited series of tests, females that had developed and commenced to lay under one 'length of day' were transferred to different conditions In no case was there any change in the type of egg laid—females that were laying summer eggs continued to do so, and vice versa

It would appear, therefore, that the effect of the photoperiod was exerted on the mite during the developmental stages, and that alterations of the photoperiod in the adult stage had no effect on the type of egg laid Whether there is any particular stage in the developmental period that is more critical has not yet been determined Nor is it known whether the effect of the photoperiod is directly on the mite or due to the photoperiodically induced substances in the leaf being taken up by the mite in its food

Recent work by Way *et al* [4], on the tomato moth, *Diataraxis oleracea* L , which overwinters as a pupa ; and by Dickson[5], on the oriental fruit moth, *Grapholitha molesta* (Busck), and the codling moth, *Carpocapsa pomonella* (L ), both of which overwinter as larvæ, has shown that these insects also enter diapause on a shortening day

Detailed work on this problem is being undertaken and will be reported elsewhere

L W. Miller

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July 31

[1] Cagle L R , Va Agr Exp Stat Tech Bull 98 (194
[2] Cottier, W , *N Z J Sci and Tech* , **26**, 39 (1934).
[3] Miller, L W , Progress Report Orchard Mite Invest Tas (1949)
[4] Way, M J , Hopkins, B , and Smith, P M , *Nature*
[5] Dickson R C *Ent Soc Amer* , *Ann* , **42**, 511

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 20

University of London (in the Physiology Theatre, University College, Gower Street, London, W C 1), at 4 45 p m—Dr A Elliott and Dr W E Hanby "Aspects of Protein Structure" * (Further Lectures on November 27, December 4 and 11 )

Passfield Trustees (in the William Beveridge Hall, University of London, Senate House, London, W C 1), at 5 p m—Prof W K Hancock "The History of Our Time" (First Webb Memorial Lecture) *

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Mr J A V Bates "The Nervous System as a Communication Network"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m—Prof E K Rideal, F R S "Surface Reactions and their Significance in Biology" (Inaugural Lecture) *

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 15 p m—Mr George Salt "An Expedition to the Shira Plateau of Kilimanjaro"

## Tuesday, November 21

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S W 7), at 5 p m—Mr H Trefor Jones "Magnesium as a Plant Nutrient" *

Royal Institution (at 21 Albemarle Street, London, W 1), at 5 15 p m—Prof J Monteath Robertson, F R S "Crystallography in Modern Science, (iv) Crystallography in Chemistry"

Royal Society of Arts, India, Pakistan and Burma Section (at John Adam Street, Adelphi, London, W C 2), at 5 15 p m—Prof R E Mortimer Wheeler "Archæology in India and Pakistan since 1944" (Sir George Birdwood Memorial Lecture)

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m—Dr R Holroyd "Some Aspects of Semi-Technical Scale Experimentation in Chemical Industry"

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m—Prof H E M Barlow "Currents and Fields in Electrical Engineering" (Inaugural Lecture) *

Royal Anthropological Institute (in the Physiology Theatre, University College, Gower Street, London W C 1), at 8 p m—Dr A A Bake "Stick Dances and Hobby-Horses in India"

## Wednesday, November 22

Royal Society of Arts (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m—Dr Albert Parker "Cities without Smoke"

Royal Meteorological Society (at 49 Cromwell Road, London, S W 7), at 5 p m—Mr G D Robinson "Notes on the Measurement and Estimation of Atmospheric Radiation", Mr H L Penman "Evaporation over the British Isles"

Research Defence Society (in the Physiology Lecture Theatre, University College, Gower Street, London, W C 1), at 5 30 p m—Prof E D Adrian, O M , F R S 'Experiments on the Nervous System" (Nineteenth Stephen Paget Memorial Lecture)

Society of Chemical Industry, Microbiological Panel of the Food Group (at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N W 7), at 6 15 p m—Papers and demonstrations on "Recent Aids to the Study of Microbiology"

## Thursday, November 23

University of London (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 1 15 p m—Mr B C Brookes "Criticism of the Literature of Science" *

Linnean Society of London (at Burlington House, Piccadilly, London, W 1), at 5 p m—Discussion on "What is Man ?" (to be opened by Prof A J E Cave)

Chemical Society, North Wales Section (in the Department of Chemistry, University College of North Wales, Bangor), at 5 45 p m—Dr F L Rose "A Chemotherapeutic Search in Retrospect" (Tilden Lecture)

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 p m—Mr A V Cleaver "Rockets and Assisted Take-off"

Plastics Institute, London and District Section (at the Waldorf Hotel, Aldwych, London, W C 2), at 6 30 p m—Mr N G H Thomas and Mr D G Cavanagh "A Survey of Polystyrene Developments"

University of London (at Wye College, Wye, Ashford, Kent), at 8 15 p m—Dr J Hammond, F R S "Adaptation in Farm Animals" *

## Friday, November 24

oyal Astronomical Society (at Burlington House, Piccadilly, on, W 1), at 4 30 p m—Geophysical Discussion on "Changes Rotation of the Earth"

cal Society (in the Physics Theatre, Imperial College of nd Technology, South Kensington, London, S W 7), at 5 p m c Papers

t the Institution of Electrical Engineers, Savoy Place, bankment, London, W C 2), at 5 30 p m—Mr J B r C W Hanson "Estimating the Cost and Value of ervices"

itution (at 21 Albemarle Street, London, W 1), at vard Appleton, G B E , F R S "The Sun as a Radio

## Saturday, November 25

British Psychological Society, Education Section (at the Child Study Centre, Coram's Garden, 41 Brunswick Square, London, W C 1), at 2 30 p m—Dr E A Peel "Testing Practical Ability"

Botanical Society of the British Isles (in the Lecture Hall, Royal Horticultural Society, Greycoat Street, London, S W 1), at 3 p m—Exhibition Meeting

British Trust for Ornithology in co-operation with the Manchester Museum (in the Chemistry Lecture Theatre, The University, Manchester), at 3 p m—Mr Stuart Smith "Aggressive Displays of some Birds", Mr A G Mason "Experiments with Corncrakes"

## Sunday, November 26

International Hæmophilia Society (at 34 Eccleston Square, London, S W 1), at 2 30 p m—General Meeting *

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# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Lecturer (with special responsibility) in the Depart Chemistry—The Registrar, Birmingham Central Technical Suffolk Street, Birmingham 1 (November 25)

Physicists (Senior Scientific Officer or Scientific Officer a Ministry of Supply Research Establishment in London handling of radioactive materials—The Ministry of Labo National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 295/50A (November 25)

Scientific Technologist I at the Coal Survey headquarters in London (duties include the recording and assimilation of Coal Survey data and the maintenance of an information service)—The National Coal Board, Establishment (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/267 (November 25)

Technical Authors in various Admiralty Naval Establishments, to prepare technical publications and handbooks on electronic equipment used in H M ships—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 49/50A (November 25)

Technical Officer (woman, with a degree in chemistry and administrative or industrial experience) in the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 380/50A (November 25)

Assistant Lecturer in the Department of Mathematics—The Secretary, Bedford College for Women, Regent's Park, London, N W 1 (November 27)

Director of Archæology, Pakistan—The Office of the High Commissioner for Pakistan, 35 Lowndes Square, London, S W 1 (November 27)

Engineer—The Clerk of the Lee Conservancy Catchment Board, Brettenham House, Lancaster Place, London, W C 2, endorsed 'Engineer to the Board' (November 29)

Electronic Engineers and Physicists (Experimental Officer grade) at Ministry of Supply Research and Development Establishments in the South Midlands—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 253/50A (November 30)

Electronic Engineers and Physicists (Scientific Officer and Experimental Officer grades) at the Royal Aircraft Establishment, Farnborough, particularly in the fields of radio communications, including microwave techniques, circuit design and measurements, servo mechanisms and measurement of flight parameters—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting D 220/50A (November 30)

Senior Lecturer in Electrical Engineering—The Director, Robert Gordon's Technical College, Aberdeen (November 30)

Veterinary Research Officers in the Department of Agricultur and Lands, Southern Rhodesia—The High Commissioner for Southern Rhodesia 429 Strand, London, W C 2 (November 30)

Agronomist in the Department of Agriculture, Gold Coast—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/249

Assistant Engineer with Power Plant experience, to the Sudan Gezira Board—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S W 1, endorsed 'Sudan Gezira Board, Power Plant, 4/292'

Chief Mechanical and Electrical Engineer, by the Directorate General of Municipalities, Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M N 24754(3B)

Mechanical Engineer to the Equatoria Projects Board, Nzara, Southern Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S W 1, endorsed 'Mechanical Engineer, E P B , 4/262'

Nutrition Officer (woman) in H M Colonial Service, Nigeria, to investigate and advise upon nutrition problems—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27321/4

Production Chemists for Royal Ordnance Factories in S W Scotland, S W England, N W England, Midlands and S Wales—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 536/50A

Senior Research Fellowship in English Agrarian History—The Registrar, University College, Leicester

Teachers (with graduate or equivalent qualifications) of Chemistry and Physics and related subjects in the Department of Science, Sheffield College of Commerce and Technology—The Director of Education, Education Office, Sheffield 1

University Lecturer in Far Eastern Art and Archæology—The Secretary of the Appointments Committee, Faculty of Oriental Languages, 56 Bateman Street, Cambridge

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# COLONIAL DEVELOPMENT AND WELFARE

THE Colonial Development and Welfare Bill, proposing to increase from £120 millions to £140 millions the sum that may be spent on Colonial development and welfare to the end of March 1956, and to raise to £25 millions the limit on the expenditure on development in any one year, which received a first reading on November 1, indicates the importance which the Government continues to attach to these purposes The recently issued Return of Schemes under the Colonial Development and Welfare Acts, April 1, 1949, to March 31, 1950*, shows the magnitude of the demand which some of these developments are already making in the scientific field alone For that reason, some recently issued papers are of interest to scientific workers concerned with such developments by enabling them to appreciate the general background against which the value of the scientific effort required has to be assessed and its expenditure justified in relation to competitive demands

The report and accounts of the Colonial Development Corporation for 1949 are indeed mainly of commercial interest, but some of the reports of the commercial and technical divisions will interest scientific men That of the Agriculture Division, for example, points out that, in view of the grave damage caused to the West African cocoa areas by swollen shoot disease, consideration has been given to the possibility of establishing cocoa in other areas, and two small projects have already been approved, one for Malaya and another for British Honduras Projects for planting oil palms and coconuts are under consideration, and certain oilseeds are included in the cropping programme of the Corporation's agricultural undertaking in Northern Nigeria

The Corporation has also given much attention to the possibilities of fibre production, especially the production of jute and jute substitutes With one exception, jute trials carried out in various parts of the world under other auspices have been unsatisfactory, and on the whole the Corporation considers that the possibilities for substitute fibres are greater than those for jute, at any rate in the Colonies Although four jute substitute fibres have shown promise for sack manufacture, the chief problem is that of finding a suitable decorticating process to replace the traditional methods of retting by soaking in water, which are expensive in man-power and involve a distasteful form of work The Corporation is also investigating several processes which may extend the use of ramie by providing technically satisfactory and economical methods of decorticating and especially of degumming

The report shows clearly that the Corporation steadily and systematically acquiring the scien and technical knowledge on such matters as soils performance of particular crops and the incide disease, the techniques of large-scale cultivati of the clearance of large tracts of virgin land, often covered with the most recalcitrant types of vegetation, upon which alone sound development can be based Besides this, however, the report discusses the broad questions of external relations and the factors that determine, for example, the possibilities of American investment in the Colonies, the costs of Colonial development undertakings, markets for Colonial produce and the Colonial economic background The indispensable foundations of development must be the provision of ports, roads, and railways, schools and hospitals These fall within the sphere of Colonial government finance, assisted by the Colonial development and welfare funds Upon this basis must be built the agricultural and industrial activities which will raise the level of production, living standards, and exports, partly by way of new undertakings, partly by the reinforcement, technical and financial, of existing enterprises, and partly by the progress of indigenous producers in modern techniques

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* Colonial Development and Welfare Acts Returns o made under the Colonial Development and Welfare Secretary of State for the Colonies, with the concur Treasury, in the Period from 1st April 1949 to 31st Ma 73 (London H M Stationery Office, 1950) 1*s* 9*d*

Compared with the Overseas Food Corporation, the Colonial Development Corporation's advance is cautious The twenty-eight undertakings started by December 1949 represent an authorized capital of £14,000,000, ranging downwards from the £3,750,000 for the Malayan Electricity Board, but only a quarter of this sum had then been spent But even more important than this financial assistance may well be the contribution which the Corporation is making to the economy of comparatively undeveloped countries by raising to a higher level the skill and enterprise of their peoples

This aspect depends so largely on the establishment of conditions of mutual respect and understanding and co-operation that it is of the utmost importance that there should be clear and widespread public understanding in Great Britain of the conditions which determine Colonial development and welfare, and the way in which they react on affairs in Britain Although territorially their scope is more limited, two other recent reports, from the Colonial Office, are even better fitted to perform that educational function The first of these, the annual report of the East Africa High Commission for 1949*, not only provides a clear account of the evolution of the Commission and of the work of its first year, but also a most valuable survey of the organization of the joint research and scientific services of that area, against which the significance of the various research schemes detailed in the Return of Schemes made under the Colonial Development and Welfare Acts can be appreciated

The mere list of inter-territorial scientific services which the High Commission has administered since its establishment is impressive To these were added 1948 the East African Railways and Harbours lministration and the East African Literature eau, and in 1949 the East African Customs and se Department On their formation the East n Information Office, Radio-communications , Regional Geological Survey and Topo- l Survey will also be administered by the High Commission, as well as such further research services as are set up on an East African basis Furthermore, besides the amalgamation and conversion of certain scheduled services, and the formulation of High Commission regulations, the work of the past year has included the introduction of special terms of service for research workers, and much progress has been made in the siting, planning and construction of headquarters of research organizations The East African Bureau of Research in Medicine and Hygiene, the Filariasis Research Unit and the East African Medical Survey were established during the year, while a reconnaissance survey in the three territories of agricultural and animal research, disease control and soil conservation, made by a team of widely experienced American agricultural research administrators, Drs Lambert, McCall and Clyne, gave the Economic Co-operation Administration and the United States Department of Agriculture a clear idea of the type of research needed and the type of American specialist who would be of most benefit to the territories

It is hoped by this means to accelerate research concerned with the general development and well-being of the peoples of Africa and the neighbouring territories The need for additional personnel, material and equipment which cannot at present be supplied by the United Kingdom was assessed, and detailed schemes are being worked out, meanwhile, the fifth chapter of the report shows how great an advance towards inter-territorial co-operation in research and scientific services has been made since Lord Hailey's "African Survey" appeared Under the East African Agriculture and Forestry Research Organization, for example, the fertilizer experiments team and the closely associated team under the Kenya Agricultural Department have continued the extensive series of fertilizer trials that began in 1947, and have provided strong evidence that the so-called 'soda-phosphate' manufactured from the Uganda rock-phosphate deposits is less effective, weight for weight, than the imported triple superphosphate Further factors are being investigated On the strength of the circumstantial evidence provided by the Clove Research Scheme that the 'sudden-de[illegible] disease of cloves in Zanzibar is a virus disease, scheme for the control of the disease on Pemba Island by a policy of swift and systematic eradication of outbreaks has been approved, this scheme, however, is at present under reconsideration owing to further evidence that the disease is so much more widespread than had been assumed that the chances of effective control throughout the affected areas by this means are slight

Towards the end of the year, it was decided to establish as rapidly as possible all central activities of the East African Veterinary Research Organization on an appropriate site in the Muguga Forest Reserve, where an area of about 900 acres is being made available by the Government of Kenya These activities are to include the long range research on animal disease and the manufacture of biological products, which was to have been located at Kabete A start has been made on the study of the bovine pleuro-

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ffice Annual Report on the East Africa High Commis- onial No 263 ) Pp ii+40+4 plates (London H M e, 1950 ) 1s 6d net pneumonia organism in the developing egg with the view of determining whether the chick embryo will serve as a laboratory animal, while in consequence of the research on 'Antrycide' which has indicated that acquired resistance is easily developed and that the period of apparent protection is considerably shorter than was suggested by early experiments, greater emphasis will be placed on further investigation of the curative value of the drug

The scheme for the establishment of a Central Trypanosomiasis Research Institute at Serkulu, Uganda, is progressing, and special attention is now being paid to evolving new methods for the study of the relationship of the tsetse to its environment, particularly local climate Valuable information on anti-tsetse measures has been obtained in the Nyanza Province of Kenya, where problems of reclamation concern *Glossina palpalis* and *G pallipedes*, at Mbarara, Uganda, and in the Jringa and Tabora districts of Tanganyika A particularly encouraging feature of these inter-territorial experimental reclamation schemes is the finding that *G morsitans* is often—and *G pallipedes* is sometimes—concentrated in relatively narrow inter-zones of vegetation associated with topography, and that bush-clearing in these strips alone has a significant effect on the fly population Recent work in the new tsetse areas seems to confirm the original findings of the workers from the Imperial Chemical Industries, Ltd, but elsewhere there have been varying results in experiments with 'Antrycide' as a prophylactic drug for enabling herds to be established in fly-infested areas, and more intensive research directed to curative effects and toxicity has been recommended

The main fishery research effort has now been diverted from *Mormyrus* to *Tilapia*, and results already obtained indicate the possibility of greatly developing this particular fishery, which is the most valuable one on Lake Victoria The research includes studies on growth, breeding and feeding, and the sex ratios of the various populations, and an attempt is being made to follow both the horizontal and vertical migrations of these fish A brief account of the major investigations pursued by the East African Industrial Research Board on ceramics, phosphate fertilizer, building materials and pyrethrum during 1949 is included No organized research programme in meteorology was possible during the year The work of the Desert Locust Survey was seriously disturbed by the appearance of swarms first, in February, in Oman, and then, in May, in the Aden Protectorate, the Yemen and south-west Saudi Arabia During the period of alarm, the Survey's officers watched the danger areas, with the exception of the Yemen, and, as a result of an international conference in October at Karachi, India, Iran and Pakistan strengthened their control organizations, and it was agreed that strenuous joint efforts should be made to control locusts in Oman Besides having to mount these control measures and send missions to the sands to study the conditions which led to the threat of the new plague, towards the end of 1949 the Survey was faced with the prospect of having to watch the coasts of Aden, Yemen, British Somaliland, western Saudi Arabia and Eritrea for incipient swarm breeding The whole of its plans have thereby been altered, but the importance of inter-territorial organization and co-operation has simultaneously received a dramatic vindication

Of the medical research side, no more need here be mentioned than that the Filariasis Research Unit formed on June 1, 1949, is endeavouring to ascertain how serious the problem is to the economy and welfare of East Africa, and is investigating methods of control and treatment, either by the use of drugs, such as 'Hetrazan', or by control of insect carriers or both The headquarters of the East African Medical Survey were moved to Muranza, Lake Province, in October 1949 It is the aim of the Survey to obtain a picture of the health of the African, and to obtain information on how best to control the more important of the commoner diseases of East Africa

The second of the two reports, that on "The British Territories in East and Central Africa, 1945–1950"*, is even more valuable as providing the background information against which the significance of all these developments can be appreciated Although this report nominally covers the five years since the end of the War, it can fairly be claimed that it presents a balanced picture of the achievements of British administration in East and Central Africa over the past half-century The chapters dealing with reconstruction and development, with research and surveys, with the development of natural resources, and with education—indeed, the whole of its nine chapters—can be read with interest and profit by all who, whether scientific men or not, are interested in Colonial welfare and development, and are anxious to form an independent judgment, not merely on the merits of particular schemes but also on the question of the comparative pace at which political and economic development is possible The objectives of political and economic development are both made plain, and whatever opinions may be held about the pace of progress it is clear from these pages how anxious are the British authorities to secure that all such advance is based firmly on the understanding and support of whatever traditional or representative authorities exist among the African peoples, whether at local or national level

The information on research and surveys in this report does not, except in one or two small points and the time period covered, add much to that contained in the report of the East Africa High Commission There is a reference to the promising results obtained in the active pursuit of research on rabbit-adapted rinderpest virus, and to the work of the Colonial Insecticides Research Unit at Arusha, Tanganyika Attempts are being made by means of experiments with group farms to devise new farming systems, capable of general adoption, which will ensure that the land is more scientifically and more efficiently worked than under the haphazard distribution of the land under traditional systems land tenure Further, an inter-territorial F African Scientific and Industrial Research Board been set up to take over the work of the East African Research Board There are comments on Makerere College, on the supply of teachers, on technical and specialist education and on the expansion of medical services

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* Colonial Office The British Territories in East and Africa, 1945–1950 (Cmd 7987) Pp iv+166 (London Stationery Office, 1950) 4s net

The record of achievement in the whole Colonial field is an impressive one, but there must be no slackening of effort, scientific or administrative Rather must the pace be increased, for no policy of 'safety first' can be either possible or acceptable to the Colonial peoples whose political aspirations have been aroused

# THE THEORY OF LIQUIDS

## A General Kinetic Theory of Liquids

By M Born and H S Green. Pp vii+98 (Cambridge At the University Press, 1949 ) 10*s* 6*d* net

THIS publication in book form of five papers on the Born–Green theory of liquids, together with a paper describing a kinetic-theory derivation of the thermodynamics of a 'quantum' assembly, is very welcome Many attempts have been made to treat liquids and solutions by statistical mechanics, and specialized models can deal with particular problems, but the total result has been decidedly scrappy Born and Green have approached the field from the point of view of kinetic theory, bringing to it both freshness of outlook and considerable insight

The new methods introduced and some of their results, particularly those in the paper on thermodynamics (Chapter 5), represent definite contributions to knowledge, but I feel that the authors have overplayed their hand in some of their claims. An example of such an exaggerated claim is the suggestion (p 23) that their fundamental integral equation may have spatially periodic solutions which represent the solid state Since the integral equation has been derived on the basis of the so-called 'Kirkwood approximation' (equation 4 6, p 5), which cannot possibly be valid for a spatially periodic lattice (although it is probably very good for a liquid well above its freezing point), this claim is at least premature (unless it can be shown that the equations still possess this type of solution even if the 'Kirkwood approximation' is not made) As it stands, the theory cannot hope to describe more than the gaseous and part of the liquid regions

Papers 1 and 2 derive the equilibrium properties of a 'classical' liquid, the 'Kirkwood approximation' playing a vital part by enabling the infinite series of differential equations, to which the general theory leads, to be replaced by an integral equation involving the distribution function $n_2(r_{12})$, which equation can be solved if two further approximations (discussed in the notes) are made The result is a theory very similar to the Mayer theory of condensation, explicit expressions for the 'cluster integrals' being obtained, and, in addition, it is known that the equilibrium properties of a liquid are all obtainable from a sufficiently accurate expression for $n_2(r_{12})$ as a unction of density and temperature It is concluded at the change-over from the vapour to the liquid se is associated with a branch-point in the free gy This conclusion, if true, represents a definite ovement on the Mayer theory, where the nature singularity is left in doubt on account of the uncertainty in the behaviour of the cluster integrals It must, however, be remembered that the work of Onsager[1] has proved that the nature of the thermodynamic singularity associated with a particular physical model can be obscured or modified by an approximate treatment, even if the approximation themselves seem quite plausible physically

Both forms of the theory, classical and quantum, seem to be equivalent to the following model. The interaction between two typical molecules is considered explicitly, while the effect of the remainder is represented by a 'smoothed' field about which very little need be assumed Strictly, this means that one is calculating a distribution function proper to a gas moving in a potential field rather than to a liquid, but the approximation probably involves little error except just above the freezing point The model is certainly an improvement on the 'cell' model of a liquid, in which just one typical molecule is thought of as moving in a smoothed field representing th others

Paper 3 represents an attempt to derive expressions for the viscosity and thermal conductivity of a 'classical' liquid An approximate formula for viscosity, similar to Andrade's, is obtained, and it is claimed that the two coefficients can be predicted exactly if the interaction between the molecules is supposed to be known Preliminary details of such a calculation are given, but the amount of work needed to complete it in an actual case looks prohibitive

I have been able to make little or nothing of this paper, having found it impossible to rescue the physics from the morass of mathematical symbols and complicated equations Just two such difficulties may be mentioned The notation used is so complicated that, despite much searching, I found it impossible to verify that the definitions of viscosity and thermal conductivity (pp. 38 and 39) agree with the standard ones If these verifications are available elsewhere, the references should have been given The other difficulty is that I was unable to find, in this paper, any discussion of the well-known paradox that the equations of mechanics, and therefore any equations derived from them, are reversible in time As pointed out by Kirkwood (1946), this paradox can only be resolved by taking account of the fact that any actual experiment occupies a finite tim which is long compared with some of the time-intervals associated with an assembly (for example, the time between atomic collisions) and short compared with others (for example, the Poincaré period of the assembly) In practice, a sharp division of the time-intervals into 'short' and 'long' can never be made, and some of the relevant time-intervals will be comparable with whatever time one takes over an experiment, this being a sign that 'thermodynamically irreversible' effects are occurring Any acceptable theory of an irreversible process must include a discussion on these or similar lines Its apparent absence in this paper is surprising in view of the penetrating discussion of the analogous question of the quantum-mechanical *H*-theorem in Chapter 5

Chapters 4 and 6 (Papers 4 and 5 in the published series) extend the above considerations to a quantum-mechanical assembly The equations of hydrodynamics are found to be formally valid for a quantum assembly provided that one recognizes two distinct definitions of temperature and pressure, which are equivalent for a classical assembly but differ for the quantum-mechanical one. This contention is certainly correct so far as temperature is concerned, it being possible to define temperature either in terms of the macroscopic properties of the assembly (thermodynamic temperature) or in terms of the distribution of velocities of the molecules (kinetic temperature) These two definitions are certainly identical in any classical assembly (whether the molecules interact or not) but will differ in all but very special quantum-mechanical assemblies Green is on much more dangerous ground in claiming that a similar situation exists for the pressure Two apparently different definitions of kinetic and thermodynamic pressures can indeed be given, but various authors claim to have proved them equivalent Although it is clear that some of these 'proofs' are invalid, it nevertheless seems likely that the two definitions are equivalent The reader is referred to a paper by Price[2] for a bibliography and a careful discussion of the controversy (Two further papers ave appeared[3,4] since this was written )

Green attempts to apply the existence of the two pressures to an explanation of the thermo-mechanical effects and the propagation of 'second sound' (thermal waves) in the low-temperature modification of liquid helium He rejects what is usually known as the 'two-fluid theory' (the phenomenological assumption that liquid helium II can be regarded as a solution or mixture of two fluids, only one of which possesses viscosity) on the ground that it leads to "physically absurd conclusions" (though no example is given) He ignores the undoubted success of the two-fluid conception in unifying a considerable body of experimental evidence (capillary-tube and oscillating-disk measurements of viscosity, fountain effect and heat-transfer, propagation of second sound), which strongly indicates that it has some physical basis, and Green's theory itself leads to very similar predictions

Even granting the existence of two distinct pressures, I consider that Green again overplays his hand in not only claiming to be able to explain, in principle, all known properties of liquid helium, but also in holding out hope that the theory can be applied to superconductivity "with slight changes" As an example of properties of liquid helium which clearly cannot be explained on the 'two-pressure' basis alone may be mentioned the 'creep' phenomena of liquid helium films It is possible, for example, to observe the 'creep' phenomenon occurring at a finite velocity ween two vessels of liquid helium II, in the absence ny measurable pressure or temperature differences ween the two ends of the film No indication at all is given of how, with or without the 'two-pressure' hypothesis, Green is going to explain either the destruction of superconductivity by a magnetic field or the Meissner effect (expulsion of magnetic field by a superconductor)

Chapter 5 contains a very interesting discussion of the quantum-mechanical $H$-theorem Green considers a general assembly perturbed by some external agency He shows that a function can be found, equivalent to entropy of the assembly, which can only increase with time, and attains its maximum value when all the states which the assembly can occupy are filled as evenly as conditions permit This result holds only if terms higher than the second order in perturbation theory are omitted The inclusion of these higher terms implies that the assembly fluctuates about its mean configuration and thus, given a sufficiently long time, would attain a configuration as far from the mean as that in which it began Green suggests that this provides a new means of studying fluctuation phenomena I agree, and consider that this paper represents a definite advance in a very difficult field, the average text-book discussion of this type of problem being unsatisfactory

The book is well printed and produced It has only been possible, because of the nature of the reproduction process, for the authors to make minor alterations in the text and to add a few 'second thoughts' in the form of notes It is a pity that the opportunity to add a list of symbols was not taken H N V TEMPERLEY

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[1] Onsager, L , *Phys Rev* , 65, 117 (1944)

[2] Price, P J , *Phil Mag* , 41, 948 (1950)

[3] Riddel, R J , and Uhlenbeck, G E , *J Chem Phys* , 18, 1066 (1950)

[4] Green, H S , *J Chem Phys* , 18, 1123 (1950)

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# STATISTICS FOR PSYCHOLOGICAL EXPERIMENTS

## Experimental Design in Psychological Research

By Prof Allen L Edwards Pp xv+446 (New York Rinehart and Co , Inc , 1950 ) 5 dollars

THE problems of experimental design in psychological research are many and varied With a legitimate desire for objectivity and purity of scientific approach, the psychologist has begged, borrowed or stolen statistical devices originally designed for other fields of research Some such borrowings have met with success Others, however, leave the doubt that their fundamental assumptions are incompatible with what can be surmised about human behaviour in the experimental situation Repetition of varying but nearly similar tasks by one subject can lead either to 'learning' or to 'boredom', or a mixture of both There is no way of telling beforehand how the subject will respond in this matter To describe it as a change of motivation may be descriptive psychology, but a significantly small order of trial variance in a standard Latin-square design is always disturbing Similarly, to formulate a null hypothesis based on independence between trials is to postulate what the results might have been had the subjects not been human There is some evidence further which suggests that rats feel the same way about experiments The research psychologist is therefore often faced with a choice either he keeps the psychology right, and produces an untidy and statistically inelegant experiment , or he keeps his statistics and hopes the psychology will only come out in the right places

This is an unsatisfactory state of affairs, and it is with raised hopes that one reads the title "Experimental Design in Psychological Research" The hopes do not survive the table of contents The book is one more elementary statistics text, with a concession to psychology in that the illustrative material is drawn from psychological sources There are many other elementary statistics text-books, some better, some worse The research worker's choice is probably dictated by predilections for order of presentation, number and nature of examples, clearness of text, or references to original work This book is neither outstandingly good nor outstandingly bad in these things Some conventions are followed which seem odd to the English reader Numbers in the text are always given as numbers—"after the rat has learned the discrimination of the 2 squares it is given a series of 8 trials with 2 circles" Pages set out in this fashion are disturbing to the rapid reader searching for a particular problem

With regard to specific contents of the book, the chapter "Probability and Experimental Design" starts off with the use of the binomial expansion, well presented although no correction is suggested to deal with the discrete values The normal distribution and $\chi^2$ distribution are then introduced as approximations The Poisson distribution is not mentioned, although Bartlett's square-root transformation is given for data recorded as number of errors per trial A welcome intrusion is the mention of the hypergeometric treatment of the fourfold table, even though it is wrongly attributed to R A Fisher, but E S Pearson's approximation which so increases its practical value is not mentioned Treatment of analysis of variance is along fairly conventional lines, and a great deal is said of factorial designs Regression makes a brief appearance in the all too brief chapter on analysis of co-variance Given the psychological emphasis, it is surprising that no mention is made of ranking statistics The statistical tables are good, and Prof Edwards is also to be congratulated on condemning, by omission, multiple correlation and factor analysis, twin pitfalls for psychologists with a taste for computation J W WHITFIELD

# PREHISTORY AND ARCHÆOLOGY OF ANGOLA

**Some String Figures from North-East Angola**
By M D and L S B Leakey Pp 24

**Museu do Dundo, Publicacoes Culturais No. 1**
Stations préhistoriques de l Angola du Nord-Est Analyse géologique, climatologique et préhistorique d'un sondage fait en bordure de la rivière Luembe (Angola du Nord-Est) Par J Janmart 2ª edicao Pp 88

**Museu do Dundo, Publicacoes Culturais No 2**
La station préhistorique de Candala (District de la Lunda, Angola du Nord-Est) e outros estudos sobre prè-históría da Lunda, por Jan Janmart As gravuras rupestres do Alto-Zambeze e primeira tentativa da sua interpretacao, por José Redinha Pp 92

**Museu do Dundo, Publicacoes Culturais No 5**
Les limons et graviers de l'Angola du Nord-Est et leur contenu archaéologique Par Prof Henri Breuil et Jean Janmart Pp 57

(Lisboa Companhia de Diamantes de Angola, 1949, 1947, 1948 and 1950 )

ONCE again the Companhia de Diamantes de Angola and its "Chef du Service de Prospection", J Janmart, and his colleagues have put prehistorians in their debt The first work is great fun and for it we have to thank Dr L S B Leakey's indefatigable energy which drove him to look for something to occupy his time during a period of wet weather Among many primitive peoples string figures play an important part, and it is delightful to have a fresh series so well set out

The second and third works (Publications Nos 1 and 2) must, of course, be taken with the companion volumes by Dr Leakey and the Abbé H Breuil The region that is now Angola played an important part in prehistoric times During dry periods when semi-desert conditions existed in many areas of South Africa, the rivers in Angola continued to flow and migrations into the area took place The opposite happened when the climate changed and damp conditions set in Angola then became a cradle area whence cultures flowed out eastwards and southwards

The Museu do Dundo Publications Nos 1 and 2 contain important information for the student The former is concerned with the finds from a large number of sites The reader may be slightly confused by the use of such terms as Kalinian (cf Lower Sangoan and Fauresmith) and Djokocian (cf Upper Sangoan) which are current in the Congo But there will be little real difficulty in correlating the finds with known cultures elsewhere, and the illustrations are helpful The second volume deals in greater detail with a particular site The geology and archæology are both considered The section on the rock engravings of the Upper Zambezi is written i Portuguese , but is not difficult to follow The art entirely geometric and consists of a series of complicated patterns, the simplest being a series of concentric circles, knots and a number of wheel-like figures with spokes Why these elaborate figures were made is unknown There is no doubt that, prehistorically speaking, Angola has been recently very much 'put on to the map'

As regards the last work here under review (Publication No 5), only recently a similar volume on the "Stone Age in Angola" appeared under the auspices of the Companhia de Diamantes de Angola from the pen of Dr Leakey The present publication deals particularly with the industries and their succession It is of capital importance both now and for any further work in this part of Africa It starts with a study of some fractured material of very early date, and the suggestion is put forward that, from analogy with exactly similar phenomena known in Europe, these fractures must in all probability be due to glacial action A glaciation in Angola at any geological period is an interesting thought, and further study will be needed before any certainty can be claimed for the hypothesis Coming to Quaternary times, the gravels from a series of terraces are passed under review and the implements found in them examined An excellent section across the valley of the Lunda makes it clear what the authors are considering There follows a discussion of certain ra later loams and their archæological contents

The volume concludes with a more detailed acco of the industries from a number of selected si which include what are described as Abbevillian Acheulean coups de poing, cores of Levallois te nique, a flake "en chapeau de gendarme" and implements of a variety of stages of the Kalinian (Sangoan) culture The work is to some extent complementary to that by Dr Leakey, and the two of them lay the foundations of the subject in the country The only criticism which can be levelled against the present one is the poorness of the drawings There are some excellent photographs which have no more than the usual limitations of photographic reproductions of stone implements, but in the drawings a genuine attempt has been made to depict exactly what the stones look like—as if they had been photographed—whereas it would have been more helpful to have indicated more clearly how the objects had been fashioned The authors are to be congratulated on an excellent piece of work

M C BURKITT

# EARLY HISTORY OF QUANTUM MECHANICS

By Prof L ROSENFELD
University of Manchester

TO inquire into the early stages of development of a scientific theory is no idle curiosity Indeed, no adequate appreciation of its present state is possible if the various aspects which have gained prominence in the course of time are not traced back to their roots This is especially true for the quantum theory of atomic systems, which presents such unfamiliar features and has led to such far-reaching conceptions as Niels Bohr's idea of complementarity The history of quantum mechanics is, in fact, particularly instructive as an illustration of the inherent logic of the growth of scientific ideas At the same time, it is not lacking in dramatic surprise it forcefully reminds us that a vigorous flight of imagination can sometimes unexpectedly quicken the pace of a more methodical progress

It would be futile to try to date the birth of quantum mechanics from a particular discovery, or to relate it to a particular name The creation of this imposing doctrine has been a work of patient and gradual approximation to the truth, and it is the result of collective—if sometimes unconcerted—efforts Nevertheless, it is possible to point to one inspiring idea, which gave the whole development unfailing guidance it is Bohr's principle of correspondence, or (as he prefers to call it) correspondence "argument" This last word serves to emphasize the fact that we are concerned not with a definitive, well-polished formulation of a natural law, but with a general point of view useful in the orientation of the search for unknown regularities of atomic systems The young physicists who nowadays solve wave-equations as a matter of routine are not always taught how essential the correspondence point of view remains for the physical interpretation of the new formalism Still less can they realize how essential an instrument it has been in the pioneering period of elaboration of this theory

Bohr's early work was taken up, in the early 'twenties, with characteristic thoroughness and energy by the flourishing German schools of theoretical physics, clustered around the figures of Sommerfeld and Born Munich and Gottingen not only became active workshops in which the properties of multiply periodic mechanical systems and their quantization were explored in all directions, but also at the same time yielded year after year a vigorous crop of brilliant young men, fascinated by the adventurous quest and fully equipped for it

In the meantime Bohr himself, with fewer but no less able disciples, pursued his equally thorough and, doubtless, more penetrating investigations Much of his work in those years was never published, but, at any rate, it inspired his close collaborators The *leitmotiv* of Bohr's profound analysis of the quantization of multiply periodic systems was the underlying correspondence between quantal and classical behaviour, and the strongly expressed conviction that a true understanding of the quantum laws would necessitate a radical departure from the fundamental conceptions of classical physics It was in this invigorating atmosphere that Kramers took the decisive step of treating the theory of optical dispersion from the point of view of correspondence This was quite a natural step in the course of the research which was systematically progressing at Copenhagen, but at the time it could certainly not have been foreseen that it would lead so rapidly to such fundamental consequences

At this juncture, the young Heisenberg arrived from Germany, and was quickly introduced to Bohr's ideas by working with Kramers at the further refinement of dispersion theory He then perceived that the quantized amplitudes of atomic resonators could be regarded as a new kind of algebraic symbol, depending on the pairs of integers which characterize possible quantum transitions, and that the rules for handling these quantities, which the correspondence argument had suggested, could be condensed into a simple mathematical law of multiplication In contrast with the simpler problems of emission and absorption, the phenomenon of dispersion was, in fact, the first case involving products of amplitudes pertaining to different transitions Heisenberg thus discovered an algebraical symbolism which was the natural instrument for expressing the kinematical (as opposed to dynamical) relationships of quantized physical entities

As to the precise nature of this algebra, Heisenberg himself was at first very much in the dark But the announcement of his momentous discovery found a quick response Born, familiar as he was with the theory of matrices developed in Hilbert's mathematical school at Gottingen, was struck by the resemblance of Heisenberg's multiplication rule with the corresponding rule for matrices With the help of one of his most gifted pupils, Jordan, he soon recognized that this resemblance was, in fact, an identity, and he was able, for the first time, to put the kinematical relation between co-ordinate and momentum found by Heisenberg into the neater and considerably more general form well known to-day as the canonical commutation rule The importance of Born's contribution was, above all, to place at the disposal of the physicists the formidable arsenal of matrix theory With this refined weapon in hand, Born, Jordan and Heisenberg were able to produce at an incredible speed the famous paper in which the complete foundation of the new quantum mechanics was firmly laid

Heisenberg's first paper, however, elicited another, highly original reaction from a Cambridge student, who at the time was one of the few engaged in the search for a rational quantum theory The way in which Dirac developed his own extension of Heisenberg's fundamental idea, leading to an equivalent and independent foundation of quantum mechanics, bears the mark of his peculiar genius Like Born and Jordan, he starts from the commutator between co-ordinate and momentum, but he is not fettered by any special representation of quantum algebra, such as the matrix calculus He goes straight back to the correspondence argument and establishes a correspondence, in this sense, between the commutator and the Poisson bracket of classical mechanics This gives him the key to the whole edifice An epic grandeur pervades this paper of Dirac's, one is reminded of Maxwell's translation of the electromagnetic field conception into mathematical symbols

In discussing the interpretation of the matrix elements in terms of transitions between stationary states, Heisenberg had stressed the fact that the new formalism was strictly adapted to observable quantities whereas auxiliary concepts like the orbits of classical mechanics were entirely eliminated This bold innovation in the attitude towards mechanical models of atomic phenomena was undoubtedly a first step in the elaboration of a logically consistent system of concepts of quantum mechanics But the sharp formulation given to it by Heisenberg had a weakness that could not long escape attention It was above all Pauli, then in Copenhagen, who directed his critical acumen to this fundamental question He presented the difficulty in a striking way by a picturesque illustration the moon is, strictly speaking, in a stationary state, yet there is no doubt about its localization on its orbit Heisenberg's philosophy of observables therefore shot beyond its mark, in fact, it obscured the correspondence with the classical theory, which ought to appear as a limiting case of the new mechanics Obviously, a more general representation of the quantum algebra than that provided by matrix theory was needed in order to account for situations in which the localization of particles plays a prominent part

Scarcely had this problem been clearly recognized among Bohr's disciples than its solution came unexpectedly from quarters quite unconnected with the trend of thought of the Copenhagen school Struck by the dual nature of light, which manifests itself both as waves and particles, Louis de Broglie had, two years before, attempted to follow up the speculative extension of this duality to matter he associated with a free particle a group of waves moving with the same velocity, and he even tried to interpret the quantum conditions defining the stationary states of a system of particles as conditions of stationariness of the associated waves These bold suggestions were taken up with great determination by Schrodinger, he succeeded in giving them an acceptable form by an ingenious application of another product of the Gottingen school, the theory of eigenfunctions, which had just received a masterly exposition in Courant and Hilbert's famous text-book

The reaction of the school of quantum mechanics to Schrodinger's work was immediate and decisive Pauli saw at once that the formalism of wave mechanics was fundamentally equivalent to that of quantum mechanics (this had also been pointed out by Schrodinger himself), and provided the desired extension of the latter for dealing with the localization of particles Born showed how the new method, in particular, was adapted to the treatment of collision processes, on this occasion, he formulated the precise rules for the interpretation of wave-functions, consonant with Bohr's views about the essentially statistical character of our description of atomic phenomena Jordan and Dirac, independently, emphasized the role of the wave-function as a canonical transformation, and worked out a comprehensive presentation of the theory, based on this concept, which entirely elucidated the relationship between stationary states and spatial localization and the general statistical features of quantum processes

The least pleased with this breath-taking development was probably Schrodinger himself He had hoped that the introduction of wave conceptions would have reconciled the kind of discontinuity expressed by the quantum postulates with a spatio-temporal picture fundamentally similar to that of classical physics in particular, his aim was to eliminate the statistical features connected with quantum transitions by means of a causal description involving wave interferences "Had I known," he declared with his usual terseness, "that we should not get rid of this jumping about (*Herumspringerei*) of the electrons, I'd rather not have intervened in this business " To which Bohr pointedly retorted "You may think so, but *we* are deeply grateful for your intervention" For Bohr and his disciples, in fact, there was never any doubt that the quantum postulates meant a radical break from the causal point of view of classical physics They hailed Schrodinger's theory as the symbolism exactly suited to a consistent formulation of the entirely new kind of non-causal relationship occurring in atomic theory Bohr's address at the Como Congress, in the autumn of 1927, fittingly concludes the phase of creation of quantum theory In it, he gives a penetrating analysis of the uncertainty relations, set up shortly before by Heisenberg, and he introduces for the first time the idea of complementarity, which expresses the essentially new logical structure of the conceptual framework of quantum mechanics

L ROSENFELD

# QUANTUM MECHANICS AND ASTROPHYSICS

By PROF. W H McCREA

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SINCE the aim of astrophysics is to study the whole physical universe, and since the concepts of quantum mechanics have permeated the whole of fundamental physical theory, it would be almost impossible completely to disentangle the influence of quantum mechanics on the recent development of astrophysics No such task is attempted here We survey only certain of the more direct applications of quantum mechanics to characteristically astrophysical situations The interest of such a survey, in the first place, lies in the circumstance that cosmical physics naturally provides a much more extensive range of physical conditions in which to apply the theory than does laboratory physics In the second place, the interest is to inquire whether further advances in atomic physics appear to be demanded by astrophysical considerations

Certain general observations are needed First, there is the remarkable fact that much of the progress in astrophysics that might appear to depend essentially upon the use of quantum mechanics was, in fact, achieved by exploiting to the utmost the potentialities of the 'old' quantum theory It so happens that the work described in Eddington's "Internal Constitution of the Stars" (Cambridge, 1926) was completed on the eve of the discovery of the 'new' quantum theory and well illustrates this point Incidentally, Eddington's book also serves admirably as an account of the position reached in general astrophysics at the beginning of the period now under review

Second, the existence of quantum mechanics has not had a very obvious effect upon the sort of observational work carried out in astrophysics. The most that can be claimed is that it may have partly determined the emphasis laid upon certain types of work, especially on the determination of profiles of spectral lines (see below). Certainly no observations can be quoted as having been designed crucially to test any particular prediction of quantum mechanics. Attention may therefore be concentrated mainly upon theoretical developments.

For our purposes here, it is more profitable to think in terms of the chief new concepts that have guided recent advances in astrophysics, rather than of the advances themselves. One would venture specially to mention among such concepts those concerning (*a*) states of matter, (*b*) formation of spectra, (*c*) nuclear reactions, (*d*) interstellar matter, (*e*) the apparent expansion of the universe. We notice briefly the significance of quantum mechanics for each of these.

## States of Matter in Stellar and Planetary Bodies

R. H. Fowler's application[1] of the quantum mechanical theory of degeneracy and of zero-point energy to account in a general way for the observed characteristics of white-dwarf stars is the most clear-cut example of the solution of an astrophysical problem depending upon features in which quantum mechanics differs essentially from any previous theory. Moreover, astrophysics provides much the most extensive applications of the properties of degenerate matter (including recently, for example, its thermal conductivity[2]) which otherwise find practical illustration of only a restricted character in the theory of electrical and thermal conductivities of laboratory materials. Further, the theory of relativistic degeneracy as developed by E. C. Stoner[3] and W. Anderson[4] and S. Chandrasekhar[5], which is generally recognized as needed for a full investigation of the white-dwarf problem, may be claimed as the most direct application yet made of Dirac's relativistic form of the wave-equation.

W. H. Ramsey[6] has recently developed a highly promising theory of the constitution of the earth and the terrestrial planets on the basis of the phase-change to a metallic state produced in their material by pressure. This is a phenomenon characteristic of the quantum mechanical theory of the 'solid' state. More recently still[7], Ramsey has extended his theory to the constitution of the major planets, with apparently satisfactory results. He has shown, moreover, how his theory provides a smooth transition from the 'planetary' to the 'white-dwarf' state with increasing mass of the body concerned. It may therefore be regarded as in principle completing the quantum mechanical treatment of the problem of this transition, the solution of which was first tentatively sketched by H. N. Russell[8] and D. S. Kothari[9].

## Formation of Spectra

Probably no single type of astrophysical observation has contributed so much in recent times to the accumulation of astrophysical knowledge as has the study of line-profiles (including, of course, the derivation of line-intensities) in astronomical spectra. This study, which is now being carried out in observatories all over the world, was started, using modern photometric methods, at Potsdam and at Utrecht in 1927, and so its development very nearly covers the period under survey. It yields a wealth of information about the physical state of the gas producing the spectral lines: its density, atomic motions and mass-motions, its state of excitation and ionization, its chemical composition, the number of its atoms producing a given line, and the radiational and electromagnetic field in which the gas is situated. This information is derived from the application of a highly developed theory of line-formation using all the resources of atomic theory, kinetic theory, and the theory of radiative transfer. It is not too much to say that the general theory of line profiles (though not necessarily in every particular application) employs almost all the most delicate developments of quantum mechanics, and has, in fact, itself stimulated many of these developments. A comprehensive review of the subject has been given by H. H. Plaskett[10], including references to the quantum-mechanical work involved.

In the general context of line-formation, one might be expected to mention the identification by I. S. Bowen[11] of the 'nebulium' lines as due to 'forbidden' transitions of oxygen, nitrogen and neon, and by B. Edlén[12] of the 'coronium' lines as due to 'forbidden' transitions of iron, nickel, calcium and argon atoms deprived of ten to fifteen electrons. The former did not, however, depend upon the use of quantum mechanics as such. The latter depended upon a variety of empirical and theoretical evidence which did include transition-probabilities depending upon essentially quantum-mechanical calculations.

A satisfactory explanation of the general opacity of the sun's atmosphere was reached only comparatively recently in terms of the negative hydrogen ion[13]. The existence of this system and its properties are purely theoretical predictions of quantum mechanics. It has not been possible to verify these by laboratory observations. Conditions in the solar photosphere are, however, precisely those which the theory demands for the operation of the predicted effects, and the calculated results accord well with the observed characteristics of the sun's continuous spectrum.

## Nuclear Reactions in Stars

The most fundamental advance in astrophysics during the period concerned has been the establishment, almost beyond doubt, of the fact that the predominant process of energy-generation in stars is the conversion of hydrogen into helium. The most important set of thermonuclear reactions involved are probably those of the 'carbon–nitrogen' cycle[14]. This advance has depended primarily upon experimental progress in nuclear physics. When the experimental results are used in deriving the formulæ required in the astrophysical applications, an essential step is, however, the appeal to a standard quantum-mechanical calculation for the probability of a proton of given energy penetrating a given atomic nucleus. Were the quantum mechanics of nuclear processes more advanced than it is at present, it would presumably lead to a more completely theoretical treatment of the subject of energy-generation than is now possible.

## Interstellar Matter

The interpretation of the observed distribution and motion of the stars in the galaxy, the study of the relation of a star to its cosmic environment, and the theory of the evolution of the whole galactic system are at the present time dominated by the study of interstellar matter[15] This is a development in astrophysics which has occurred mainly within about the past ten years The total amount of the matter is probably about the same as that condensed into stars It consists mainly of hydrogen, with a presumably small percentage of helium, and something of the order of one atom in 50,000 of heavier elements It is mostly in the form of gas, including a small admixture of molecular combinations (CH, NH), but about one per cent is in the form of interstellar 'dust' The density in a typical region is of the order of one atom per cubic centimetre

Since the condition of the material is far removed from thermodynamic equilibrium, its state can be studied only by an exhaustive consideration of all the atomic processes of excitation, ionization, condensation, etc , taking place Most of these processes at some stage require quantum mechanical considerations Without going into more detail, it can therefore be seen that quantum mechanics is intimately involved in this great new development of astrophysics

## The Expanding Universe

There is no generally accepted relation between quantum mechanics and the concept of the expanding universe further mention of this is deferred to the concluding section

## General Significance

In the above brief summary it has not been possible to discuss the quantitative comparison of theoretical with observational results Broadly speaking, it may be claimed that, wherever the comparison may legitimately be regarded as providing a test of the predictions of quantum mechanics, the agreement is found to be satisfactory having regard to the uncertainties in the astrophysical observations and the numerical approximations in the theoretical work

Astrophysical research does not appear to have revealed any limitations in quantum mechanics beyond those encountered in the development of the theory itself or those known to laboratory physics But, in spite of the fact that astrophysics provides a much wider range of application than does laboratory physics, it is only fair to recognize that in most of this extended range it does not yet provide very stringent numerical tests In the most characteristic astrophysical applications the position is rather that without quantum mechanics it is impossible to come within sight of a solution, than that the quantitative results of the quantum-mechanical calculations can yet be claimed to be verified within even a few per cent

## The Future

It may first be asked how expected developments in atomic theory are likely to influence astrophysics The greatest developments in the near future are expected to be in nuclear physics If a new 'quantum mechanics' of the atomic nucleus does emerge, it is bound to influence all parts of astrophysics concerned with nuclear processes—those proceeding in normal stars and those in supernovæ and other 'abnormal' stars In this way it may be expected to yield a greatly improved understanding of the observed relative abundances of the chemical elements and thence to yield new knowledge about the evolution of the universe

In the present setting it is, however, more pertinent to ask whether further developments in theoretical atomic physics appear to be indicated or required specifically by problems in astrophysics There are, of course, many unsolved problems in astrophysics the formulation of which carries no implication whatever that existing general physical theory will prove inadequate for their solution On the other hand, the problems of the origin of cosmic rays, the origin of stellar and other magnetic fields, the polarization of light in its passage through interstellar space, and the nature of the recently discovered 'radio-stars', are ones that may conceivably have to await fresh developments in atomic physics for their solution However, none of these problems is yet in the position that, for example, the white-dwarf problem was in twenty-five years ago, when Edd[illegible]ton had shown how the application of then ex[illegible] theory actually led to a paradox

In a most fundamental regard, astrophysics does, however, point the way to a great development in general physics. For it is impossible to avoid the conviction that the parameters of the whole observable universe, its size, its mass, and Hubble's constant for the recession of the galaxies, must be related to the fundamental constants of atomic physics The discovery of the relations was the aim of Eddington's later work, though his particular ideas have gained little acceptance A more promising approach may be through the concept of continuous creation in the form recently proposed by Bondi and Gold[16] and by Hoyle[17] For in their view the parameters of the universe are determined by the creation-rate, which is itself an 'atomic' parameter If the relations are established, in this or any other way, they must presumably show why the galaxies have the ages, sizes, and so on, which are inferred from observation, and thence, in turn, why the stars have their observed masses, etc —in short, why the universe is what it is observed to be—all in terms of an extended quantum mechanics The underlying problem is the well-known one of the unification of quantum theory and relativity theory Astrophysics certainly supplies the phenomena for which an adequate solution must account and has possibly already, through the hypothesis of continuous creation, brought the solutio[illegible] one stage nearer achievement

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# QUANTUM MECHANICS AND LOW-TEMPERATURE RESEARCH

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AND
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LOW-TEMPERATURE physics is to-day an important and flourishing part of physics Fifty years ago, before the advent of the quantum theory, this was not so In the classical picture we have the law of equipartition of energy, according to which "degrees of freedom are counted only, and not weighted" This means, for example, that the specific heat of a solid is constant down to absolute zero, which in turn implies that between any finite temperature and absolute zero all entropy differences are infinite

This fact has two consequences it is impossible to attain absolute zero , and we cannot extrapolate entropy data to absolute zero This point is therefore of no particular thermodynamic interest, and certainly cannot be used as a reference point for equilibrium calculations Experimental workers in the pre-quantum times do not seem to have expected much more than to find repeated with one substance of lower boiling point what was already known with other substances of higher boiling point, and similarly not to have expected to find any striking new phenomena in the electrical and magnetic behaviour of materials This is perhaps expressed a bit too crudely, for in every experiment there is the element of curiosity and the hope of the unexpected, best exemplified perhaps by the work of Dewar and Kamerlingh Onnes , but, as a whole, low-temperature research had no wide appeal

All this was changed with the development of the quantum theory and the discovery and interpretation of low-temperature quantum effects Most decisive, perhaps, was Einstein's explanation of the falling off of specific heats and the prediction that they would approach zero at zero temperature Entropy differences now become finite between absolute zero and finite temperatures, and absolute zero becomes a thermodynamic reference point of the highest importance At about the same time, this had been expressed in the enunciation of Nernst's Theorem, derived intuitively from considerations concerning chemical equilibria at ordinary or high temperatures It finally led to the statement that entropy differences between all states of a system, which are in internal equilibrium, disappear at absolute zero In a somewhat abbreviated way one can say that substances in a state of thermodynamic equilibrium at absolute zero are in a state of perfect order—a state of affairs only possible in a quantum world This, the Third Law of Thermodynamics, is to-day the most important guiding principle in low-temperature research It is true that this Law also entails the unattainability of absolute zero, but in a different sense It no longer constitutes an obstacle to our knowledge, for we can now extrapolate properties to absolute zero

Quantum effects are thus the dominating interest in low-temperature research One of the most important is zero-point energy In the second form of the quantum theory, Planck assumed that the energy of a vibrator in the lowest state was not zero but $\frac{1}{2}h\nu$, which led to exactly the classical energy at high temperatures Lindemann first showed that there must be a difference in the behaviour of the vapour pressure of isotopes with or without zero-point energy The indications at the time supported it, but they were not conclusive Further indications of the zero-point energy were given by the study of the melting point and of the law of corresponding states The first quantitative proof came from the study of X-ray diffraction intensities at low temperatures Later the study of the spectra of diatomic molecules confirmed this Finally, the new quantum mechanics showed the necessity of zero-point energy, and to-day many exact proofs exist for it

The most striking example is perhaps liquid helium. Here the small atomic mass of helium, leading to strong quantum effects, combined with weak interatomic forces, giving a very small lattice energy, result in a zero-point energy of the same order as the lattice energy Consequently helium cannot solidify and is thus prevented from reaching the state of perfect order in the normal way Instead, it passes into a state of liquid degeneracy (helium II), with all the remarkable effects on which much of the interest in low-temperature physics is now concentrated.

Gas degeneracy, another quantum phenomenon exhibited at low temperatures, depends for its explanation on a deeper aspect of quantum mechanics —the symmetry of wave functions, which expresses the indistinguishability of identical systems, such as molecules Application of this symmetry principle to hydrogen gives the explanation of the behaviour of ortho- and para-hydrogen as two virtually separate components of hydrogen, with different specific heats Gas degeneracy takes two forms, characterized by the Bose–Einstein and the Fermi–Dirac statistics, corresponding to symmetry or antisymmetry of wave functions with respect to the interchange of identical systems It has been conjectured, with some plausibility, that the unique behaviour of helium II is due to a similar 'liquid degeneracy' This question is of considerable interest at the present moment, for the very rare isotope of mass 3, of which small quantities are now becoming available for experiment, obeys the Fermi–Dirac statistics, while the normal isotope of mass 4 obeys the Bose–Einstein statistics Interesting differences in behaviour are expected, and some are already found

Electrons, being very light, exhibit degeneracy to an extreme degree, even at high temperatures when their density is high, as it is in metals This explains their very small contribution to the specific heat of metals, which only becomes noticeable at very low temperatures, when the lattice specific heat becomes even smaller The variation of electrical and thermal conductivities with temperature is satisfactorily explained only in terms of ideas which are definitely quantal The phenomenon of superconductivity still remains without an accepted explanation, however, although it is clear that it also is an essentially quantal phenomenon

The magnetic behaviour of materials at very low temperatures is of particular importance for low-temperature physics, for the lowest temperatures are attained by magnetic methods Here again, quantum mechanics has played a determining part in the understanding of the phenomena Bohr's old quantum theory gave a general explanation of paramagnetism and diamagnetism in terms of the quantization of angular momentum But the new quantum mechanics, with its unambiguous rules for dealing with the angular momentum of complex atoms and the magnetic effect of the spin of the electron, is necessary to give a quantitative theory adequate for low-temperature research Future developments, in the way of even lower temperatures, involve an even greater reliance on quantum mechanics as a guide to the interaction between the magnetism of nuclei and the thermal motion of the lattice, through which the attainment of these very low temperatures is to be effected

It will be seen from this very brief survey that modern low-temperature research derives its chief interest from the impetus of the quantum theory It is difficult to separate the old and the new quantum theory in this development The old theory was adequate for the theory of the specific heats of solids, and up to a point for the understanding of gas degeneracy and magnetism, the new theory is required for a quantitative explanation Ortho- and para-hydrogen, on the other hand, could scarcely have been intelligible in terms of the old theory In the theory of metals, the specific heat could have been understood on the old theory, supplemented by Pauli's principle (actually contemporaneous with the birth of the new quantum mechanics, but independent of it), but conductivity can only be fully understood in terms of the new Quantum mechanics, in its modern form, is certainly necessary for the understanding of those phenomena connected with extreme degeneracy, in which macroscopic systems exhibit quantal features usually only found in the atomic domain, such as superconductivity and helium II Much has been learnt in twenty-five years; but the subject is not closed, and there are still many promising lines of research to follow, though it would perhaps be too optimistic to hope that any revolutionary development of physical theory will come from low-temperature research

# OBITUARY

## Sir Sidney Harmer, K B E., F R S

The death of Sir Sidney Frederick Harmer on October 22 after long years of disability removed the last survivor of a remarkable group of naturalists on the staff of the University of Cambridge in the closing decades of the past century Alfred Newton, Adam Sedgwick, Bateson, Gadow, Harmer, Hickson, Sharp —all of them fellows of the Royal Society—each one of them, by original research, teaching and personal influence, playing an important part in the advancement of zoological science

Born in Norwich in 1862 with a heritage of ability which had found expression in his father's rise to high position in business and in public affairs, Harmer had the further advantage of a childhood spent in an atmosphere of interest in science, his father being an enthusiastic student of the palæontology of East Anglia His formal training in zoology was initiated at University College, London, and carried forward at Cambridge, where in due course he obtained first-class honours in the Natural Sciences Tripos, Parts 1 and 2, a University lectureship in zoology, and a fellowship of his College (King's) In 1891 he succeeded J W Clark as superintendent of the University Museum of Zoology

As a University teacher, Harmer's duties were concerned with the advanced training of students who had already obtained honours in Part 1 of the Tripos His teaching was admirably designed to give a balanced and judicial summary of existing knowledge of the particular section of the animal kingdom with which he was dealing, while at the same time inculcating these ideals to be aimed at in all scientific work—industry, patience and accuracy in observation, clarity and precision in record, and abhorrence of hurried clutching at results Harmer's capacity as a teacher is well brought out by his section, "Polyzoa", in the "Cambridge Natural History", of which great work he acted as joint editor with Shipley His admirable articles in the "Encyclopædia Britannica" —more especially those on Polyzoa and Cetacea— provide further testimony to this capacity

In the field of original research, Harmer's Cambridge activities were specially concentrated upon the Polyzoa, he adhered loyally to J V Thompson's name for the group in spite of the more general use of Ehrenberg's "Bryozoa" His long series of memoir on the classification, morphology, physiology an distribution of the Polyzoa brought him world-wi recognition as perhaps the leading authority on the group Almost at the beginning of the series is his remarkable work on *Pedicellina,* while its culmination is found in his report upon the Polyzoa of the *Siboga* Expedition, which he regarded as the most important of all his works

An important side-issue of Harmer's work on the Polyzoa was his investigation of a remarkable little animal, *Cephalodiscus,* first obtained by the *Challenger* Expedition At first regarded as a compound Ascidian, it was later thought to be a polyzoon, and as such came under the notice of Harmer, who as a result of detailed investigation demonstrated the surprising fact that *Cephalodiscus* was no polyzoon but rather an ally of *Balanoglossus,* and therefore of the Chordata

During Harmer's later years in Cambridge, his teaching and research activities were encroached upon by the administrative work falling to the superintendent of the Museum of Zoology In this post he was a great success, combining the acquisitive instincts proper to the museum curator with the greatest care in classifying and cataloguing, and the scrupulous conscience which regarded gifts to the Museum as sacred even when they no longer roused particular topical interest

Harmer's reputation as superintendent of the University Museum of Zoology led to his appointment in 1907 as keeper of zoology in the British Museum (Natural History), this in turn leading up to his appointment in 1919 as director of the Natural History Museum His appointment followed the publication in *The Times* of March 1 of that year of a letter signed by twenty-two leading men of science, with a relevant leading article, inspired by leakage of a recommendation by the general body of British Museum trustees to the three principal trustees (the electoral body) that they should appoint as director a layman, the very efficient assistant secretary

The directorship of the Natural History Museum, involving the official leadership of British naturalists, meant inevitably the broadening out of Harmer's activities over an area which cannot be adequately covered in the space here available Outstanding among them must be mentioned his vice-chairmanship of the "Discovery" Committee, one result of which was to revive and intensify his old interest in the Cetacea An important outcome of this was his organizing machinery for reporting, through the coastguards and receivers of wrecks, all strandings of whales noted around the coasts of Britain This led to a great increase in the amount of material available for study by specialists on the Cetacea, and as a result to important advances in knowledge Mention must also be made of Harmer's long and active interest in the Marine Biological Association and the work of the Plymouth laboratory

On retiring from the directorship of the Museum in 1927, Harmer was able to concentrate upon his *Siboga* Report, of which Parts 1 and 2 had appeared in 1915 and 1926. Parts 3 and 4 were duly completed, but the text and illustrations of Part 4 unfortunately reached Holland just before the German occupation of that country, and their supposed loss was a blow from which Harmer never really recovered When eventually news came of heir safety, it was too late to bring relief Happily they are now in the capable hands of Dr Anna Hastings, and the publication of this concluding part of Harmer's great work should not be long delayed

Harmer's last years were spent at Melbourn and then at Cambridge, where he died He is survived by his wife, Laura, daughter of A P Howell, and by their son and daughter

His scientific work received wide recognition He was knighted in 1920 Elected a fellow of the Royal Society in 1898, he served on the Council and was vice-president during 1922–24 Fellow of University College, London , honorary fellow of King's College, Cambridge , president of the Linnean Society of London , foreign member of the Norwegian and Swedish Academies , honorary member of the Boston Society of Natural History and the Société Zoologique de France , gold medal of the Linnean Society of London , these were among his long list of distinctions JOHN GRAHAM KERR

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# NEWS and VIEWS

## Nobel Prize for Chemistry for 1950: Prof O Diels and Prof K Alder

THE Nobel Prize for Chemistry for 1950 has been awarded jointly to Prof Otto Diels and his former pupil, Prof Kurt Alder, for their work on the diene synthesis This award will be acclaimed by organic chemists generally as a fitting acknowledgment of one of the outstanding achievements of organic chemistry The names of Diels and Alder will be inseparably linked in the annals of chemistry, and their combined names with the diene synthesis which they developed Prof Diels, who will shortly celebrate his seventy-fifth birthday, has been professor of chemistry at the University of Kiel since 1916 Prof Alder now occupies the chair of chemistry and chemical technology in the University of Cologne Their first paper on the reaction of dienes with quinones was published in 1928 Similar additions had already been recorded by other workers, and in particular by von Euler and Josephson, who in 1920 described the reaction of isoprene with benzoquinone and correctly formulated the product It was Diels and Alder, however, who provided the first experimental proof of the nature of the reaction and who appreciated and demonstrated its wide application to the synthesis of ring compounds of many types The ease with which the diene synthesis occurs, without the need for powerful chemical reagents, is one of its most remarkable features, and study of the reaction has also contributed greatly to knowledge of polymerization processes by which plastic materials of great practical value have been obtained It is probable that many plant products are formed in Nature by diene additions Prof Alder, who is still actively working on the diene synthesis, has made important contributions to the stereochemistry and the energetics of the process Prof Diels is also noted for his work on other aspects of organic chemistry, and in particular for his studies on cholesterol, which culminated in his discovery of the method of dehydrogenation with selenium

## Royal Society Medal Awards for 1950

H M THE KING has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1950 as follows Sir Edward Appleton, for his work on the transmission of electromagnetic waves round the earth and for his investigations of the ionic state of the upper atmosphere , Dr C F A. Pantin, for his contributions to the comparative physiology of the Invertebrata, particularly his work on nerve conduction in Crustacea and Actinozoa

The following awards of Medals have been made by the President and the Council of the Royal Society Copley Medal to Sir James Chadwick, for his outstanding work in nuclear physics and in the development of atomic energy, especially for his discovery of the neutron , Rumford Medal to Air Commodore Sir Frank Whittle, for his pioneering contributions to the jet propulsion of aircraft , Davy Medal to Sir John Simonsen, for his distinguished researches on the constitution of natural products, especially the plant hydrocarbons and their derivatives , Darwin Medal to Prof F E Fritsch, for his distinguished contributions to the study of algology , Hughes Medal to Prof M Born, for his contributions to theoretical physics in general and to the development of quantum mechanics in particular

## Royal Observatory, Cape of Good Hope: Dr J. Jackson, F R.S.

DR JOHN JACKSON has recently retired from the post of H M Astronomer and Director of the Royal Observatory, Cape of Good Hope Dr Jackson was appointed chief assistant at the Royal Observatory, Greenwich, in 1914 He edited the double-star observations made at Greenwich, which he used together with observations elsewhere for the investigation of the orbits of many binaries and for the determination of dynamical parallaxes In conjunction with Mr Bowyer he made a study of the performance of the Shortt free-pendulum clocks , the effect of the short-period nutation terms was shown, and it became necessary to introduce the conception of mean or uniform sidereal time The reduction, jointly with Dr H Knox-Shaw, of the observations made by Hornsby at the Radcliffe Observatory, Oxford, in the years 1774–98 was an important contribution to fundamental astronomy In 1933 Dr Jackson was appointed H M Astronomer at the Cape, and has fully maintained the high traditions of that important southern Observatory The stellar parallax programme and the photographic determinations of star places were vigorously continued

The analysis of the proper-motions of 20,843 stars, derived from the Cape astrographic plates, was of special importance to stellar statistics, because of their wide range in galactic latitude Under his directorship the Cape Observatory has undertaken an extensive programme of stellar photometry, providing for the first time photographic and photovisual magnitudes of high accuracy of many stars in the southern sky Dr Jackson has been president of the Commission on Meridian Astronomy of the International Astronomical Union, and is now president of the Commission on Stellar Parallaxes and Proper Motions

### Dr R H Stoy

Dr R. H Stoy, who succeeds Dr Jackson and so becomes the ninth H M Astronomer at the Cape, has been chief assistant at the Royal Observatory, Cape of Good Hope, since 1935 Born at Wolverhampton and educated at King Edward VII School, Birmingham, he went to Gonville and Caius College, Cambridge, to continue his mathematical studies From an early age he had been interested in astronomy and he continued to work on this subject After taking his degree, he was awarded a Commonwealth Fellowship and went to the Lick Observatory, where he spent the years 1933–35 He investigated problems connected with the spectra of nebulæ, for which work he was awarded a Ph D degree at Cambridge His interest in practical astronomy made him an ideal astronomer for the Cape Observatory, where he went on returning from the United States At the Cape he found that a large programme of work had been started to determine the positions and magnitudes of stars down to the ninth magnitude south of dec − 30° For the positional work the necessary framework was already available, and it was hoped to determine the brightness of the stars by means of standards at declination − 45° Dr Stoy soon found that the standards available were not sufficiently accurate, and a great deal of his time during the past ten years has been concerned with the setting up of accurate standards at declination − 45° for both photographic and visual magnitudes, and connecting them with the best standards in the sky north of the equator visible from South Africa In this work he collaborated with Prof R O Redman, now director of the Cambridge Observatories, but working at the Radcliffe Observatory, Pretoria, until 1947

### Voyage of the Royal Research Ship *William Scoresby*, 1950

The Royal Research Ship *William Scoresby* recently arrived in Plymouth after a ten-month voyage of research on oceanography and whales in South African waters This veteran research ship was built twenty-four years ago for the Discovery Committee and is equipped for general oceanographical work, trawling and marking of whales The voyage has been a continuation of the Discovery Investigations, and the whole work is controlled by the National Institute of Oceanography (see *Nature*, January 21, p 105) The principal items of research during the voyage were surveys of the Benguela Current off South-West Africa at two different times of year, and whale marking and a short survey of the Agulhas Current in south-east African waters The investigations of the Benguela Current included a series of observations on the physical, chemical and biological features of the waters, carried out during the first part of the voyage and then repeated during September–October In this region, cold water wells up from the ocean depths, bringing nutrient salts to the surface and thereby stimulating the growth of marine life But, in spite of the rich marine life, the sea floor in this locality is remarkable for a considerable area of sterile mud containing hydrogen sulphide, and the researches of the expedition should add considerably to present knowledge of the extent of the sterile region It has been suggested that the deposit of organic debris which takes place in such 'azoic' muds is connected with the formation of oil deposits The whales marked in the south-east African region and at various other points in the voyage included a high proportion of sperm whales, a species the habits of which are little known, and this part of the work is the first occasion on which any substantial numbers of whales have been marked in tropical and subtropical waters During most of the voyage, Mr R Clarke was in charge of the scientific work, assisted by Mr R I Currie

### Modern Developments in Radio Engineering

In his presidential address to the British Institution of Radio Engineers on September 27, Mr P Adorian pointed out that during the coming year the Institution will be celebrating its twenty-fifth anniversary and that plans are being made to hold a convention to cover many fields of radio engineering He then gave a brief survey of achievements in recent years in radio engineering with an indication of possible future developments, particularly in matters concerning industrial electronics, aeronautics and broadcasting Mr Adorian emphasized that, while radio engineers seem to appreciate that numerous production and operation methods could be made more efficient by the use of electronic techniques, it is surprising to find how little of this knowledge is applied in practice in industry and in medical science In the field of aeronautics, while modern air transport would be impossible without radio communication and navigational aids, there seems to be a need for speeding up and simplifying signalling methods to keep pace with the steadily increasing speed of modern aircraft

After reviewing the progress of broadcasting towards the ideal of providing a satisfactory service in all populated areas of the world, Mr Adorian referred briefly to a relatively new method of using short-wave radio for the provision of a local service Basically, the system consists of high-frequency transmitters with aerials which radiate mainly in a vertical direction, giving relatively short-range reflexions from the ionosphere The first of these systems began operating in India several years ago, in 1947 Radio Trinidad started to broadcast on this principle on a wave-length of 30 m (10 Mc /s ), while last July a station of the same type was installed in Jamaica, using a wave-length of 60 m (5 Mc /s ) Local reception is satisfactory during daylight, but at night interference is experienced with the transmissions from distant high-power stations operating on the same frequencies

### Biology and Control of Pharaoh's Ant

The most familiar ant in houses in Great Britain is the common black ant *Lasius niger*, but a much more serious pest when it occurs is the tiny insect known as Pharaoh's ant, *Monomorium pharaonis* (L ), which measures less than three millimetres in length A monograph by Prof A D Peacock and others, recently published by the Department of Agriculture for Scotland (Misc Pub No 17, pp

51, Edinburgh and London H M Stationery Office, 1950, 1*s*), gives a detailed account of the biology and control of this insect The authors attach more importance to poison baits than to contact insecticides as a means of control Pieces of liver are smeared at suitable points, with the object of locating the nests and establishing regular trails This is termed 'pre-baiting' The poison bait, consisting of thallium sulphate and sodium fluoride mixed with syrup and liver or minced meat, or of sodium silico-fluoride and dried liver, is securely enclosed in tins suitably perforated to allow access by the ants and placed in the line of the established trails The poison bait must be renewed once a week, and it is usually necessary to continue the process for six months or more before the entire brood in the nests has been effectively poisoned Needless to say, these measures will be successful only if they are combined with a campaign for general hygiene and cleanliness

## niversary of Elliott Brothers, Instrument Makers

As a part of the celebrations this year of its 150th anniversary, the firm of Elliott Brothers (London), Ltd, is compiling a record of its activities and would like to hear of the whereabouts of Elliott instruments made during the nineteenth century The firm originally made drawing and surveying instruments and acquired the business of Watkins and Hill about the middle of the past century The available catalogues show that the products included many types of optical apparatus, as well as electrical apparatus which was supplied to the early experimenters The company developed a calculating machine known as the arithmometer and, towards the end of the century, supplied a wide range of electrical indicating and recording instruments and telegraphic apparatus Unfortunately, many specimens of this old apparatus and interesting photographs were destroyed during the Second World War, and the company would welcome any information about their early products Correspondence should be addressed to Mr A H Attwood, Elliott Brothers (London), Ltd, Century Works, Lewisham, S E 13

## University of Glasgow

For the new session this year 250 new admissions have been made to the Science Faculty of the University of Glasgow Altogether the University now has 6,645 matriculated students (5,298 men, 1,347 women), which is about 350 fewer than a year ago In the Department of Chemistry, N Grassie and V Vand have been appointed Imperial Chemical Industries, Ltd, fellows Dr Grassie, a graduate of Aberdeen, will continue his study of the kinetics of high-polymer reactions which he started at the University of Birmingham Dr Vand graduated in physics and mathematics at the Charles University, Prague, and goes to Glasgow from Lever Brothers and Unilever, Ltd, his work is in the field of X-ray crystal analysis and has special reference to mechanical methods of computation Dr R P Korf, a mycologist from the Department of Plant Pathology, Cornell University, with a particular interest in the taxonomy of the Discomycetes, is at the Botany Department of the University for a year on an exchange with Dr S A Hutchinson The librarian and keeper of the Hunterian Books and MSS, Dr W R Cunningham, has resigned as from March 31, 1951

## Institution of Civil Engineers: Awards

The Institution of Civil Engineers has announced the following awards for papers read at meetings or published in the *Journal* during the session 1949–50 *Telford Premiums* R G Braithwaite and D J Davies, jointly, for their paper on "Welded Highway Bridges", and G M Binnie for his paper on "Some Notes on the Karun River and the Shatt-el-Arab" *Telford Premiums* for papers read at meetings of the following Engineering Divisions *Railway Engineering Division*, A H Toms and W F Beatty, *Structural and Building Engineering Division*, W S A Atkins, *Works Construction Division*, D Lumbard and A A Wright, *Maritime and Waterways Engineering Division*, R A Stephenson, *Airport Engineering Division*, F S Snow *Coopers Hill War Memorial Prize* to Dr A S Thom for his paper on "Investigation of Tidal Phenomena in the Clyde Estuary, using a Scale Model" *Indian Premium* to Rai Bahadur B B Gupta for his paper on "Some Causeways on Sand Foundations across Rivers in India and their Development to Submersible Bridges" *Miller Prizes* for papers by students of the Institution to A Moores, P Heatly, C B Wilby, J A G Clarke, J R Willetts, R J Anderson, D J D Wood, D J Skinner and H E Elliott *Institution Medal and Premium* for a paper by an undergraduate of the University of London to J R Taylor

## Institute of Navigation

The following have been appointed officers for 1950–51 of the Institute of Navigation *President*, Sir Robert Watson-Watt, *Vice-Presidents*, Air-Commodore C E Chilton and Captain G C Saul, *Honorary Treasurer*, F G G Carr, *Chairman of the Technical Committee*, R F Hansford, *Chairman of the Executive Committee*, L P Kirwan, *Other Members of the Council*, Dr E Adams, E L T Barton, Air Chief Marshal Sir Frederick Bowhill, Francis Chichester, Commander C E N Frankcom, A H Jessell, Commander W E May, D H Sadler, Sir Harold Spencer Jones, Captain G W Wakeford and Captain F J Wylie

Rear-Admiral Gordon McLintock, U S M S, and Admiral of the Fleet Sir Henry Oliver have been made honorary fellows of the Institute

## International Congresses during 1951

In 1951 the following meetings associated with international scientific unions which are members of the International Council of Scientific Unions will take place *Astronomy:* The Eighth General Assembly of the International Astronomical Union will be held in Leningrad and Pulkovo during August 1–8 *Chemistry:* The Sixteenth Conference of the International Union of Pure and Applied Chemistry commences in New York during September 8–9 after the meetings of the American Chemical Society (September 3–7), and will be concluded in Washington, D C, during September 14–15, on which dates the National Bureau of Standards in Washington will be celebrating its fiftieth anniversary The Twelfth International Congress of Pure and Applied Chemistry will be held in New York during September 10–13 *Crystallography:* The Second General Assembly and Congress of the International Union of Crystallography will be held in Stockholm during June 27–July 3 Following this there will be two symposia, on advanced techniques in structure determination and on electron diffraction in liquids and gases respectively Enrolment and offers of papers for these meetings should be made before February 15 *Geodesy and Geophysics:* The Ninth General Assembly of the International Union of Geodesy and Geophysics will take place in Brussels during August 21–September 1 The Assembly will be concerned with geodesy, hydrology, meteorology, physical oceanography, seismology, terrestrial magnetism and electricity and vulcanology The Royal Society, through its British national committees, is the adhering body for Great Britain to each of the Unions, and available information on these Congresses can be obtained from the assistant secretary of the Royal Society, Burlington House, Piccadilly, London, W 1

## Christmas Lectures

A SERIES of three Christmas lectures, specially adapted for a juvenile audience of from twelve to seventeen years of age, will be held in the Royal Photographic Society's House, 16 Princes Gate, London, S W 7, at 3 p m on December 28 and 29, 1950, and January 1, 1951 The lecturers and subjects will be as follows "Slow-Motion Photography", by Mr E W H Selwyn, "How a Colour Photograph is Made", by Mr L W Oliver, and "How to Photograph Buildings", by Miss Margaret F Harker Admission will be free but by ticket only, obtainable on application to the Secretary of the Society at the above address

A series of three Christmas lectures on "Railways How They are Built and How They Run", for boys primarily between thirteen and seventeen years of age, will be given at the Institution of Civil Engineers, Great George Street, London, S W 1, at 3 p m on December 29, 1950, and January 1 and 3, 1951 These lectures are a repetition of the ones given four years ago, and the speakers will be Mr Cecil J. Allen, Mr L G B Rock and Mr O S Nock Admission will be free but by ticket only, obtainable from the secretary of the Institution at the above address

## The Night Sky in December

NEW moon occurs on Dec 9d 09h 28m, U T, and full moon on Dec 24d 10d 23m The following conjunctions with the moon take place Dec 4d 08h, Saturn 3° N, Dec 10d 18h, Mercury 3° N, Dec 12d 01h, Mars 3° N, Dec 14d 13h, Jupiter 0 9° N, Dec 31d 18h, Saturn 4° N In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on Dec 27d 21h, Mercury being 2 2° N Mercury is an evening star, setting thirty-five minutes after the sun on December 1 and an hour and three-quarters after sunset on December 15, but towards the end of the month it draws too close to the sun for favourable observation Venus is an evening star but is too close to the sun during most of the month for favourable observation, on December 31 the planet sets at 16h 45m and can be seen for a short time in the western sky, stellar magnitude $-3$ 4 and practically all the illuminated disk being visible Mars is an evening star and sets about 18h 40m throughout the month Jupiter is an evening star, setting at 22h 25m, 21h 40m and 20h 55m on December 1, 15 and 31 respectively Saturn, a morning star, rises at 1h 20m on December 1 and at 23h 30m on December 31 Only one occultation of a star brighter than magnitude 6 occurs during the month, namely, 27 Taur *m*, which disappears at 15h 52 9m as observed at Greenwich The Geminid meteors are active during the first week of December, the radiant is close to θ Geminorum Winter solstice is on Dec 22d 10h

## Announcements

THE French Ministry of Education has conferred on Miss E Simpson, assistant secretary of the Society for Visiting Scientists, the honorary rank of Officier d'Académie in recognition of the work which she has done at the Society in the field of Anglo-French scientific co-operation

MR P H T HARTLEY, of the Department of Zoological Field Studies, University of Oxford, has been appointed by the Council for the Promotion of Field Studies to be warden of Flatford Mill Field Centre in succession to Dr E A R Ennion

DR JOHN W TAYLOR has been appointed deputy director-general of the United Nations Educational and Cultural Organization (Unesco) and will take up his duties in Paris on January 1 Dr Taylor was born in Kentucky in 1905 and has been president of Louisville University since 1947 He was responsible for establishing in Louisville the first U S radio station for broadcasting educational and cultural programmes to the general public and to schools

DR W H Glanville, director of the Road Research Laboratory (Department of Scientific and Industrial Research) has been elected president of the Institution of Civil Engineers for 1950–51 The following officers have also been elected S J L Egerton (*treasurer*) and E Graham Clark (*secretary*)

THE Rockefeller Foundation has made available to the University of Cambridge up to 7,000 dollars for the purchase of research equipment and supplies for the Department of Chemistry and up to 5,000 dollars towards the purchase of equipment for research in X-ray crystallography at the Cavendish Laboratory

THE Pharmaceutical Society has received the sum of £1,000 on trust to establish a Humphreys Jones Scholarship in commemoration of the centenary year of the Liverpool School of Pharmacy and Mr Humphreys Jones's association with the School for more than forty years

THE Commonwealth Fund is offering three new fellowships open to British professional journalists with university or similar qualifications for a stay of about one year in the United States, commencing in September 1951, with the object of studying the factors affecting public opinion and general conditions in the United States The fellowships are restricted to journalists of 25–35 years of age, who must be nominated by a responsible newspaper or journal Applications must be sent in before January 1, 1951, to the Warden of Harkness House, 35 Portman Square, London, W 1

A VERY limited number of the complete series of "Excursion Guides" of the Seventh International Botanical Congress (for the complete series of twenty-four, 25 kronor) are available to libraries and botanical institutions until April 1, 1951, after which any copies that might be left over will be made available to individuals "Communication No 4" (including the general programme) of the Congress (2 kronor) and also a limited number of copies of "A Short History of Botany in Sweden", by Rob E Fries (10 kronor), are generally available These publications are obtainable from Dr Ewert Åberg, Office of the Secretary-General, c/o Seventh International Botanical Congress, Uppsala 7

# MECHANISM OF ACTION OF ORGANO-PHOSPHORUS COMPOUNDS AS INSECTICIDES

By K. A. LORD and C. POTTER
Rothamsted Experimental Station, Harpenden, Herts

RECENTLY organo-phosphorus compounds have been widely used as insecticides Those chiefly used here have been 'Parathion' or *E* 605 (main active principle O O. diethyl O *p*-nitrophenyl thiophosphate), hexaethyl tetraphosphate (HETP) and tetraethyl pyrophosphate (TEPP) Hall and Jacobson[1], and Dvornikoff and Morrill[2], have published data indicating that the main insecticidally active constituent of the latter two compounds is tetraethyl pyrophosphate

These materials have a high mammalian toxicity, generally attributed to their activity as anti-cholinesterase agents. It has also been shown that they inhibit insect cholinesterases[3-5] However, the toxicity of tetraethyl pyrophosphate and 'Parathion' as contact insecticides cannot be directly related to their activity as anticholine esterases, since the former is the more potent enzyme inhibitor whereas, in many instances at least, 'Parathion' is the more potent insecticide.

Some preliminary investigations with extracts of adult *Tribolium castaneum* Hbst and larvæ of *Tenebrio molitor* L. demonstrated the ability of these extracts to hydrolyse ethyl butyrate and *o*-nitrophenyl acetate, but not acetylcholine Furthermore, hydrolysis was inhibited by tetraethyl pyrophosphate-containing materials.

Further experiments with extracts of a number of insect species in different stages of development, namely, eggs and larvæ of *Diataraxia oleracea* L (tomato moth), eggs of *Ephestia kuhniella* Zell (Mediterranean flour moth), larvæ of *Plutella maculipennis* Curt (diamond black moth) and the apterous viviparous parthenogenetic females of *Macrosiphum euphorbiæ* Thos and *Acyrthosiphon pisum* Harris, showed that they all possessed the ability to hydrolyse *o*-nitrophenyl acetate and that hydrolysis was inhibited by tetraethyl pyrophosphate-containing materials at low concentrations

From this work it appeared that the inhibition of esterases other than choline esterase might play an important part in the mechanism of action of the organo-phosphorus compounds. A study was then made of the correlation between the capacity of ten samples of materials containing different amounts of tetraethyl pyrophosphate to inhibit the esterase activity of an extract of *Tenebrio molitor* L larvæ and their toxicity as contact insecticides to adult *Tribolium castaneum* Hbst The results of these experiments, which are summarized in Table 1, suggest that tetraethyl pyrophosphate content, esterase inhibition and contact insecticidal activity are interdependent, although there is a rather closer correlation between content and esterase inhibition than between content and contact toxicity

Table 1 CORRELATION BETWEEN TETRAETHYL PYROPHOSPHATE-CONTENT, CONTACT INSECTICIDAL ACTIVITY AND ANTI-ESTERASE CAPACITY FOR THREE INSECT SPECIES

| Sample No | T E P P content (% w/v) | Relative anti-esterase activity | Relative potency* as contact insecticides | | |
|---|---|---|---|---|---|
| | | | *T castaneum* adults | *M euphorbiæ* apterous viviparous partheno-genetic females | *P maculipennis* final instar larvæ |
| 1 | 6 2 | 6 | 18 | 22 6 | 20 0 |
| 2 | 11 6 | 18 | 30 | 29 2 | 25 6 |
| 3 | 11 8 | 15 | 28 | 39 4 | 33 2 |
| 4 | 15 0 | 25 | 36 | 36 | 36 |
| 5 | 18 2 | 32 | 34 | — | — |
| 6 | 20 2 | 40 | 44 | 51 6 | 32 6 |
| 7 | 28 0 | 40 | 70 | 79 5 | — |
| 8 | 40 2 | 44 | 59 | — | — |
| 9 | 63 5 | 79 | 93 5 | — | — |
| 10 | 75 1 | 100 | 92 5 | — | — |

* Sample No 4 was taken as the standard of reference

Table 2 A COMPARISON BETWEEN THE RELATIVE ANTI-ESTERASE ACTIVITY OF 'PARATHION' AND TETRAETHYL PYROPHOSPHATE-CONTAINING MATERIALS AND THEIR RELATIVE CONTACT INSECTICIDAL ACTIVITY

| | 'Parathion' | Sample No 7 TEPP content 28% w/v | Sample No 8 TEPP content 40 25% w/v |
|---|---|---|---|
| Relative anti-esterase activity | 1 | 2 4 | 2 6 |
| Relative toxicity *Tribolium castaneum* Hbst, adults | 27 | — | 1 |
| Relative toxicity *Phaedon cochleariæ* Fab, adults | 25* | — | 1* |
| Relative toxicity *Plutella maculipennis* Curt, larvæ | 6* | — | 1* |
| Relative toxicity *Diataraxia oleracea* L, eggs | 29 | 1 | — |
| Relative toxicity *Ephestia kühniella* Zell, eggs | 125 | 1 | — |

* Probit regression lines not parallel relative toxicity measured at the M L C

Tetraethyl pyrophosphate-containing materials have also been shown to be toxic to eggs of *Diataraxia oleracea* L and *Ephestia kuhniella* Zell, which contain enzymes hydrolysing *o*-nitrophenyl acetate and inhibited by tetraethyl pyrophosphate High concentrations of the poison were required to obtain a high mortality, but it was capable of killing the eggs at an early stage of development before the differentiation of the nervous system These results also suggest that enzymes other than cholinesterase of the nervous system may be important in the poisoning of insects by these materials

The contact insecticidal activity and anti-esterase activity of 'Parathion' was compared with that of tetraethyl pyrophosphate-containing materials (see Table 2). It was found (in agreement with other authors using cholinesterase) that whereas the tetraethyl pyrophosphate-containing materials were more potent enzyme inhibitors than 'Parathion', the latter was considerably more potent as a contact insecticide to five species of insects used It is suggested that the tetraethyl pyrophosphate-containing materials are less effective as contact insecticides than 'Parathion', although they are more potent esterase inhibitors, because they are unstable and hydrolyse rapidly This view is supported by experimental data, obtained here, showing that tetraethyl pyrophosphate may act more rapidly than 'Parathion', when applied as a dust at high concentrations. Under these conditions, comparatively large amounts of toxicant are present and toxic action is rapid, so that hydrolysis during the process of penetration to the site of action and at the site of action may be expected to be of minor importance Reduction of the concentration below a certain critical value results in an increase in the time for a reaction to occur, in these circumstances, instability apparently becomes of importance, since below a certain concentration tetraethyl pyrophosphate is non-toxic although the more stable 'Parathion' is toxic at much lower concentrations, the time for a reaction to occur increasing progressively as the concentration is reduced

It is proposed to publish a full account of this work elsewhere [Aug 2

[1] Hall, S A, and Jacobson, M, *Indust Eng Chem*, **40**, 694 (1948)

[2] Dvornikoff, M N, and Morrill, H L, *Anal Chem*, **20**, 935 (1948)

[3] Chadwick, L E, and Hill, D L, *J Neurophysiol*, **10**, 235 (1947)

[4] Metcalf, R L, *Chem Biol Coord Centre*, Rev No 1, Nat Res Counc, Washington, 71 (1948)

[5] Metcalf, R L, and Marsh, R B, *J Econ Ent*, **42**, 721 (1949)

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# WATER AT A DEPTH OF − 5 FT. DISCOVERED BY DIVING IN PEAK CAVERN

By Dr R E DAVIES
University of Sheffield

DURING the exploration of the completely flooded Buxton Water Passage of Peak Cavern, Castleton, Derbyshire, on August 17, 1947, a chamber in the roof was discovered (Fig 1), 300 ft from the diving base, in which the water at the top was 5 ft 7 in above the nearby free air-water surface in the cave

The exploration was made using diving dresses and self-contained oxygen-breathing apparatus, and depth was measured with Bourdon gauges This place has been named the Torricellian Chamber, and the following observations exclude water pumps, Venturi effects or gas-fixing micro-organisms as the cause of this novel phenomenon The walls of the Chamber are smooth, have erosion facets, and are free from holes The velocity of the water in the flooded passage below the Chamber is normally only about 1 in /sec Samples of the water and scrapings from the walls contained the normal and negligible amount of water organisms when tested bacteriologically, and showed no uptake of gas when shaken in air in standard Warburg manometers

Regular observations of the Torricellian Chamber were made for many months with the results shown in Fig 2 When gas was released into the Chamber, either from the diving equipment or by means of a hosepipe from the nearby Forward Halt 1, it was found that it remained *in situ* for months during normal conditions, but was entirely removed by the major floods which occasionally fill the cavern Minor floods were less effective Two questions must be answered how is the water-level raised, and how is it maintained ? Fig 2 shows that the raising of the water-level follows the flooding of the cave and that the level remains constant (± 1 in ) whatever its height in the intervening periods

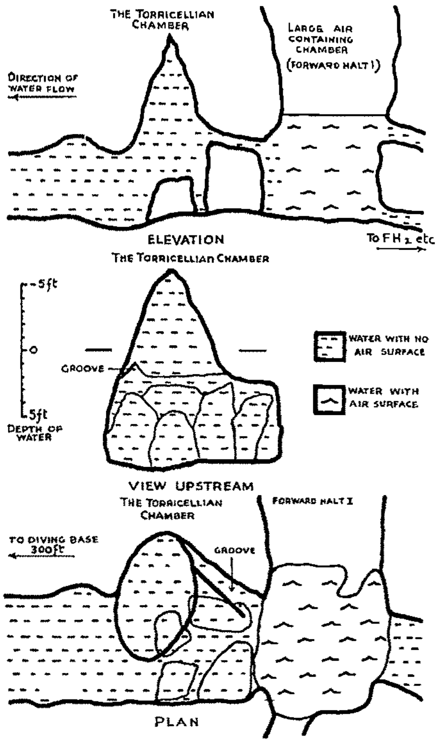

Fig 1 Elevation, view upstream, and plan of the Torricellian Chamber in the Buxton Water Passage of Peak Cavern

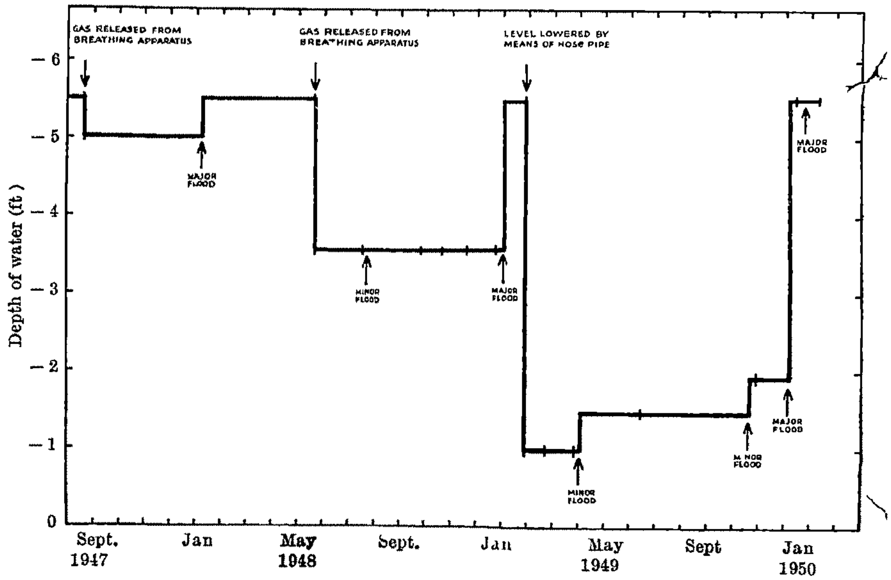

Fig 2 The 'depth' of water in the Torricellian Chamber from August 1947 to January 1950 (A minor flood covers the path in the Five Arches Passage, a major flood rises up the Devil's Staircase and fills the whole Cavern )

Since the local cave water is saturated with air at 1 atm , the system cannot be in equilibrium and air should diffuse out of the water and so fill the Chamber The diffusion constant of air in water at the cave temperature of 8° C is 1 4 × $10^{-5}$ c c gas at N T P /cm $^2$/min at a pressure gradient of 1 atm /cm [1]. Thus even if as little as the top 1 cm of the water were stagnant, the water-level would fall at only about 1 cm /year A model can be made by leaving an inverted test-tube full of water in a small water-filled beaker It takes many months for the water-level to fall and reach equilibrium That such natural unequilibrated air pockets can persist for long periods was also shown by the discovery, in the Swine Hole – Resurgence Passage, of an air–water surface below a conical pocket in the roof at a depth of 11 ft. This pocket could be filled by bubbles [illegible]ed along during floods , but the air dissolves so [illegible] during normal conditions that it was full of [illegible]nough there had been no floods for months

Another proof that the air–water system in the Torricellian Chamber is not in equilibrium was shown after gas from the breathing apparatus had been released into the Chamber on May 16, 1948, and samples of the gas collected on October 17, 1948, from the Chamber, Forward Halt 1 (Fig 1), and a bubble on the roof of the Buxton Water Passage at a depth of 5 ft Analyses showed these contained 29 4, 19 3 and 17 6 per cent oxygen respectively Oxygen is more soluble in water than nitrogen, so the low values in the dissolving bubble and in Forward Halt 1, where the air had been breathed for some hours, are therefore expected The high value in the Chamber shows that even after five months the oxygen released had not reached equilibrium with the water The problem of the maintenance of these water-levels is therefore satisfactorily explained by the slowness of diffusion in the conditions which obtain in the flooded part of the cave

The actual removal of the air is associated with major floods (Fig 2), and it is possible that during these floods a whirlpool is formed and the air in the chamber passed down the vortex and carried away down the passage A detailed examination showed that a gap in the pile of boulders just upstream from the Chamber could direct a jet of water obliquely upwards which would hit one side of the rock and start a whirlpool, and that there is an eroded inverted V-groove in the rock roof from this gap to the edge of the Chamber Experiments with a jet of water from a normal laboratory tap showed that air could be removed down a vortex in even such a disadvantageous shape as that of a standard 1-litre measuring cylinder, which could be filled when upside down if its rim were dipped into water Water spirals up round the walls and then down the centre with greatly increased velocity It has a narrow, irregular hollow core down which the air escapes During major floods, so much water passes through Peak Cavern that velocities greater than 20 m p h certainly occur by the boulder jam near the Torricellian Chamber Dr G K T Conn, of the Physics Department, University of Sheffield, has calculated that this velocity is amply sufficient to produce instability in the Rankine vortex formed in the Chamber, so that the pumping action would begin and remove all the air When the flood subsides the Chamber will be left completely full of water

A final proof that a whirlpool is formed was obtained on January 7, 1950, when the Chamber was visited during an incipient flood Handfuls of mud from the floor of the Passage were released into it, and this showed that the water was swirling round slowly There had been a major flood on December 19, 1949, and there was no trace of air in the Chamber

The formation of a system with water at a depth of −5 ft 7 in in this Chamber in Peak Cavern is thus explicable on the basis of the occurrence of whirlpools during the periodic floods, and the maintenance depends on the slowness of diffusion relative to the interval between floods

These observations were made by or with the co-operation of the following members of the Cave Diving Group F G Balcombe, D A Coase, W H Davis, G W. Mack and J A Thompson We wish to thank the Duchy of Lancaster for permission to explore Peak Cavern, and the custodian, and members of the Sheffield University Mountaineering Club for assistance [Aug 11

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[1] "International Critical Tables", 5, 62

# BRITISH PHARMACEUTICAL CONFERENCE, 1950

THE eighty-seventh British Pharmaceutical Conference was held in Glasgow in September 1950 and was attended by more than six hundred persons The chairman, Mr A B Powell, appropriately took as the subject of his address, progress in the pharmaceutical field during the past half a century Advances, he stated, have run parallel with, and have been influenced by, advances in the cognate sciences of chemistry, physics and medicine, and are reflected in the present emphasis on preventative treatment, such as the use of vitamins, and on devising compounds with specific action against the causal organisms of disease, rather than on the palliatives formerly used chiefly for the relief of symptoms This change can be readily seen if a modern pharmacopœia be compared with one of fifty years ago The plasters and pill masses have disappeared and a host of new drugs and preparations appear, such as antibiotics, sera and vaccines, œstrogens, insulin, liver preparations, heparin and hormones The introduction of a large number of injections for parenteral use indicates a further change, namely, in the method of administration of drugs

The study of the constitution of naturally occurring compounds of proved activity gradually led to the knowledge of the effects of certain molecular groupings, and in turn to the development of chemotherapy Chemotherapeutical research is directed to the production of compounds with toxic effects against invading organisms, yet without harmful effects on the host Some early results of this new approach still play a large part in modern treatment, for example, aspirin, procaine, barbiturates and mepacrine Later, Domagk (1935) discovered the antibacterial activity of prontosil and thus initiated the enormous amount of research work which has produced the variety of sulphonamides now available The discovery of penicillin has opened up in a like manner an entirely new range of remedial products—the antibiotics The use of these new types of drugs has stimulated advances in methods of formulation and administration, in methods of biological assay, in analytical technique, and in methods of controlling purity using physical instruments such as the spectrophotometer and fluorimeter

These rather spectacular advances in the treatment of disease, however, may give us a distorted picture of the situation unless we remember that the mass of knowledge of the older drugs which has accumulated over the centuries is still being added to and used in modern treatment It is needful to recall the warning given by a famous physician "not to dismiss the accumulated experience of 3,000 years on the evidence of the latest galvanometer reading" Mr. Powell concluded his address by demonstrating the effect which legislation and progress in social welfare during the past half-century have had upon the practice of pharmacy

The research papers which were read and discussed at the science sessions formed an interesting commentary on the chairman's address While several of the papers were concerned with the newer drugs such as acridines, vitamin $B_{12}$, heparin and blood plasma, there was a number concerned with the constituents, preparations and evaluation of the older drugs. Further papers dealt with the problems involved in the newer methods of formulation, production and analysis of pharmaceutical materials

A paper on the tuberculostatic activity of some semithio carbazones (E M Bavin *et al*) well illustrated the fact that the incorporation of the chemical characters of two therapeutically active compounds into one molecule cannot be relied upon to produce an active resultant Those compounds, which represent a combination of the two active substances 4-amino-salicylic acid and 4-acetamidobenzaldehyde thiosemicarbazone and which would be expected to be highly active, were found to be inactive Attempts to overcome this loss of activity by blocking possible hydrogen-bonding effects were unsuccessful Incidentally, the *in vivo* activities of these compounds were tested by the comparatively rapid 'corneal test' and 'survival test', both of which were found to be satisfactory. In another paper, R C Kaye recorded the results of a polarographic study of the redox characters of the amino acridines, and suggested that the bacteriostatic effects of these drugs may be due to their ability to accept electrons to form stable free radicals, such binding of fugitive electrons would tend to terminate chain reactions essential to the life of the bacterial cell Vitamin $B_{12}$, the recent isolation and use of which have occasioned much interest, was the subject of a paper concerned with the important problems of the control of its purity and its stability, especially during the sterilization of aqueous solutions intended for injection

The papers which dealt with the older drugs showed that in this field there is still a considerable amount of research necessary so that the most effectual use can be made of naturally occurring remedies Pelletierine tannate of the British Pharmacopœia was shown to bear little resemblance to the original alkaloids present in *Punica granata*, from which it is prepared The present methods of manufacture lead to changes in the naturally occurring alkaloids and result in a great loss in their therapeutic activity Two papers on senna pod furnished scientific evidence for the general opinion that the fresh infusion is the most active preparation of this drug, they also showed that the concentrated preparations of the British Pharmacopœia have low activity, and stated the principles on which active concentrated extracts could be made. Two independent papers on pancreatin criticized the British Pharmacopœia method of assaying this animal product and suggested improved methods the use of which should result in products of reasonable activity and uniform potency being marketed

The problems which arise as a result of improvements in pharmaceutical practice were reflected in those papers which dealt with tablet making, bacterial survival during spray-drying processes, the sterilization of the oily basis of thermo-labile drugs and the preparation of liquid human plasma

The introduction of new ancillary materials also brought new items for investigation, for example, the use of alginic acid in tablet making and the use of non-ionic detergents in the manufacture of emulsions and creams J W FAIRBAIRN

# SOCIETY FOR APPLIED BACTERIOLOGY

## ANNUAL GENERAL MEETING

THE twenty-first annual general meeting and conference of the Society for Applied Bacteriology was held at the University of Nottingham during September 20–23 More than ninety members and guests attended one or more sessions of the conference. The resignation of the editor of the *Proceedings* of the Society, Dr T Richards, of the University of Reading, was announced, and Dr S. E Jacobs, of the Imperial College of Science and Technology, London, and Dr L F L Clegg, of the Ministry of Agriculture, Wolverhampton, were appointed joint editors. Eleven papers and four demonstrations were presented during the three paper-reading periods, and these will appear in full in the *Proceedings* in due course

Dr Jacobs gave results of experiments on bacterial control of the flour moth (*Ephestia kuehniella* Z) The normal method of dealing with this pest is fumigation In laboratory experiments, using a proprietary bacterial spore powder, it was found that considerable mortality occurred among larvæ exposed to a 3 0 per cent concentration, but that at 1 0 per cent the result was not so effective Further experiments showed that concentrations of 0 5 and 0 3 per cent completely prevented development of young larvæ A larger trial in sheds showed that after sixteen weeks the flour from sheds treated with spore powder had a markedly reduced number of larvæ and moths It was concluded that dusting with bacterial spore powder offers a measure of control and may be a useful adjunct to existing methods

Some aspects of pollution of well-water supplies and methods for eradication were discussed by N R. Knowles, of Queen's University, Belfast It was shown that transformation from a polluted to a reasonably pure water supply could readily be attained by relining the upper 6–12 ft of existing wells with concrete blocks carefully cemented together and raising the well head above ground-level to prevent surface seepage The practice of siting wells adjacent to farm buildings cannot be recommended and should be discontinued

Experiments designed to improve the bacteriological control tests of ice-cream in Northern Ireland formed the basis of a paper from J Patton, of Queen's University, Belfast Four conclusions were suggested that boxes containing solid carbon dioxide should be used for transporting ice-cream samples, that the minimum time/temperature for the pasteurization of ice-cream mixes should be 165° F for ten minutes, that the gravimetric method of preparing the initial dilution for colony counts should be used rather than volumetric measuring, since the former gives a more reproducible result, and that the present plate-count and coliform tests provide better information for determining the hygienic quality of ice-cream than the methylene blue test

A note on bacterial die-back and canker of poplar was presented by K A Sabet, of the Botany School, Cambridge This disease, which does not appear to have been critically studied in Great Britain, was first recorded in Britain in 1923 The condition is attributed to a *forma speciales—Pseudomonas syringæ* [illegible]*van Hall) f sp Nov* The presence of bacterial slime [illegible] essential for the organism to establish itself in the [illegible]t tissues and produce typical symptoms In[illegible]ction, which develops slowly, takes place in early summer only

The effect of overnight refrigeration on the results of the bacteriological examination of farm water supplies has been investigated by G E Jones, Miss P M Franklin and S B Thomas, of the National Agricultural Advisory Service (Wales) Their results showed that about twenty per cent of water samples examined twenty hours after sampling, following eighteen hours of storage at 3–5° C, had a significantly lower coliform content when compared with determinations made at two hours Samples with more than 50 coliform organisms per 100 ml of water at the initial testing time seldom showed an increased content after refrigeration overnight These results confirm the findings of other workers The colony count at 37° and 22° C did not reflect this reduction in numbers

Miss R E A Allen, of King's College, Newcastle, described types of micro-organisms isolated from the rotting surface of water-proofed rope Using soil-burial tests, Miss Allen isolated ten distinct mould strains and seventy-one bacterial species of which five were Gram-positive and sixty-six Gram-negative rods No cocci were isolated *Pseudomonas* sp. predominated among the Gram-negative rods. The water-repellent was capable of supporting a varied flora of Gram-negative bacteria

An analysis of farm milk rejections over the past six years was presented by Miss C. Campion, I. A Howard and Miss B. M Fischer, of Job's Dairies, Feltham While during this period many supplies were rejected due to taints, the majority were rejected for simple souring, and no single factor, common to all producers, could account for the rejections The conclusion was reached that milk of acceptable quality can readily be given under existing methods of production and that this quality is within the control of the milk producer himself

The value of high-frequency electric fields as a method for large-scale efficient sterilization at non-lethal temperatures has attracted the attention of a number of investigators Dr S E Jacobs, Miss M J Thornley and P Maurice, of the Imperial College of Science and Technology, London, presented a short paper on some experiments designed to study bacterial survival in high-frequency electric fields The conclusion was reached that the high-frequency techniques at present available fail to induce high mortality It is possible that a marked effect might be obtained only at highly critical frequencies since all complex molecules have natural frequencies of oscillation, and if an intense field could be applied at the right frequency it might be possible to disrupt the bacterial cell So far such an effect has not been observed.

Three papers were presented by workers in the Research Department of Messrs Boots, Nottingham The treatment of infections with combinations of chemotherapeutic agents was discussed by B H Chantrill The results illustrated the efficiency of penicillin against streptococci and its ineffectiveness against salmonella. Streptomycin was shown to be reasonably active against salmonella, and more so than penicillin In mixed infections penicillin is a disappointing therapeutic agent With penicillin and streptomycin in a mixed infection, a well-marked synergic effect occurs

In the second paper Miss B Croshaw discussed the experimental evaluation of anti-tuberculosis drugs The guinea pig test is considered the most reliable and gives a reproducible result; but a susceptible strain of mice produces a quicker test and requires much less of the drug In Miss Croshaw's experiments the intracerebral method of injection of mice was used, and a more uniform infection obtained This method is now being tried with various drugs, the activity of the drug being assessed by the extent of lung involvement when the animals are killed after treatment.

The third paper, by A Royce and G Sykes, reviewed aspects of sterilization by candle filtration It was found that the bubble pressure response of a filter candle can be used as a reliable indication of its filtration efficiency and that a response of 17 lb /sq in. or more will safely filter sterile a nutrient solution over a period of seventeen hours. This conclusion may require to be modified if solutions containing wetting-agents are involved

Two demonstrations from the Research Department of Messrs Boots dealt with the culture of viruses in eggs, by L Dickinson, and the microbiological assay of antibiotics and vitamins, by D G. Lewis and F M Mulholland Miss B M Fischer (Job's Dairies, Feltham) and Miss M Fielding (Nottingham Co-operative Society) showed the complete Astell roll tube apparatus, and G. E Jones (Wye) demonstrated the preparation of a modified pectate gel medium

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# CONTROL OF ELECTRICAL MACHINES

A VACATION school on the control of electrical machines was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during September 18–22 The school, which was under the chairmanship of Prof. Willis Jackson, was attended by some sixty engineers, drawn from industry, research associations, the universities and technical colleges

The opening address was given by Mr W M Couch, deputy director of electrical engineering at the Admiralty, who referred to the rapid developments being made in electrical engineering and the need for exchange of ideas He said that the increasing use of automatic control equipment will aid productivity, and the study of the common basis of the many techniques in use is very opportune Mr B Adkins, of the British Thomson-Houston Co, Ltd, discussed in the first lecture the general principles of the subject, giving illustrations of open-loop and closed-loop systems and outlining the mathematical techniques employed in their analysis During the discussion the need for improved nomenclature was voiced, and the respective spheres of application of the Laplace transform and Heaviside's operational calculus were discussed

In the next lecture, Mr M W Humphrey Davies, of Imperial College, described the action and properties of the several forms of two-stage machines used in rotating amplifiers In the ensuing discussion attention was directed to the proportionality between the inherent time-constant and power amplification in these machines Mr D Wray, of the English Electric Co , Ltd , spoke next on magnetic amplifiers, giving the outline theory of their action and a review of their principal applications Their use in push-pull, and dependence on supply voltage, were later discussed Lecturing on electronic amplifiers, Dr W G Thompson, of the General Electric Co , Ltd , showed how grid control of thyratrons or mercury-arc rectifiers would give flexible control schemes The advantages and disadvantages of electronic methods were compared, and discussion continued on the different techniques needed with electronic devices, and the need for special training of maintenance staff

Large D C machines, their design limitations and the controls which can be coupled without external amplifiers, were then discussed by Mr E P Hill, of the Metropolitan-Vickers Electrical Co , Ltd The effects of iron paths and coupled circuits on time-constants were treated in the discussion. Mr A A L Bentall, of the Metropolitan-Vickers Electrical Co , Ltd , followed, illustrating the control of D C machines in various combinations with a wide selection of industrial applications The great flexibility of these machines was emphasized and invoked a varied discussion on their industrial uses The control of A C machines was dealt with by Mr A Asbury, of the English Electric Co , Ltd , who outlined the methods of controlling large induction and synchronous motors which find particular application where the largest powers are required Questions of dynamic braking and unbalanced voltage control were raised in the discussion, during which the smaller A C machines also received some consideration

On September 21 a visit was paid to the Kemsley Paper Mill of the Bowater Lloyd Pulp and Paper Mills, Ltd , where examples of the control of electrical machinery were described and illustrated by Mr A C G Witts and his colleagues of the Bowater organisation The automatic control schemes for paper machines and wood grinders were of particular interest

On the concluding day, Mr W Spence, of the British Thomson-Houston Co , Ltd , gave a concise summary of the methods of combining control apparatus into a complete closed-loop control system and of assessing the resulting performance The discussion emphasized the necessity for close collaboration between machine designers, control engineers and users Mr A Asbury dealt finally with the calculation and measurement of the constants of electrical machines and methods for testing a complete control cycle It was clear from the examples quoted in the discussion that calculated and measured constants are frequently at variance, and methods for reducing the discrepancies were suggested

The general impression given from the whole course was that rapid progress is being made in the design of control systems and in the appraisal of the relative merits of different schemes There is still, however, need for a better appreciation by users of the importance of specifying their performance requirements as precisely as possible, and for not asking for a closer control than is really necessary, if they require an economical system

# FINANCIAL INCENTIVES

IT is generally recognized in industry that the provision of adequate incentives for the ordinary worker is one of the ways to improved industrial production The most obvious and, to some, the most satisfactory form of incentive is more money for better work For this reason there has been [illegible] marked growth of interest in industry, and partic[illegible]larly among the smaller firms, in the introductio[illegible] financial incentives schemes. The British Institute of Management has therefore issued a pamphlet describing the most popular wage incentive scheme, methods which have been suggested for introducing and applying them, and elaborating the conditions necessary to their success*.

Before an employer or manager introduces a new financial incentive scheme, it is emphasized that he should first ensure that the tooling, layout, material and finished goods, servicing and general methods of production cannot be improved within the limitations of capital expenditure available Neither will a new wage incentive system be successful unless good relations exist between management and workers The scheme should be introduced gradually after effective consultation with the workers, while all supervisors should be informed in the early stages of all details of the scheme Collective agreements in the industry governing the fixing of basic rates and minimum piecework guarantees should be considered, and rates governing the scheme must cover all possible contingencies

When the ground has been prepared, the particular scheme to be introduced must be carefully selected, having regard to factors such as the type of production in operation, for example, unit, batch or flow production, the type of labour employed, the grouping of production workers, whether or not skilled time-study operators are available, the probable continuity of supplies, materials and parts, the degree of mechanization of the process and the existing level of earnings of the workers

Of the wide range of incentive systems which has been evolved the following are representative of the more commonly used

First is the system of straight piece-work with a guaranteed minimum wage involving the payment of a uniform price for a unit of production , this system is suitable where production is repetitive in character and can easily be divided into similar units The system has the advantage of being easily understood and earnings are simply calculated

Secondly, there is the differential piece-work scheme, which is suitable where types of production are similar to those specified for straight piece-work and characterized by similar advantages and limitations In order to enhance the incentive effect of the straight piece-work system some differential piece-work schemes include a method whereby the piece-work price is increased where normal output in a given time is surpassed , these are useful for encouraging the less-skilled worker

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* Organizing for Output Pp 66 (London British Institute of Management, 1950 ) 2s 6d.

Thirdly, there are the time-saved bonus schemes in which time study is used for setting a standard time, a reward additional to a guaranteed minimum being given to employees who complete the task in less than standard time Among these are the Gantt method, which provides for the payment of a minimum hourly rate of 66 6 per cent efficiency on the specified task, at which point the rate begins to increase on a graduated scale. The scheme is useful for machine jobs liable to delay and where expensive machines are operated Under Emmerson's efficiency method a time is fixed for the job, and the outstanding worker who is able to complete it in this time is regarded as 100 per cent efficient or as representing the unit of efficiency Where a worker takes longer than the [illegible] time a calculation of his efficiency is made [illegible] any efficiency in excess of 66 6 per cent (which represents the minimum time-rate) a bonus is paid on a sliding scale, yielding 10 per cent bonus on 90 per cent efficiency The scheme is useful for gradual transition from day-work to a high-incentive piece-work plan

Schemes of a similar nature include the Halsey system, the Rowan system and the standard hour plan

Fourthly, there is the point system, which introduces a new element into wage incentive systems. In place of task times and production units, the point system evaluates a piece of work in time units which purport to take account of the amount of skill and energy required for its efficient performance and also for the amount of rest an average worker needs during its performance In one scheme, for example, the unit of one minute represents the expenditure of energy plus allowance for recovery, there being sixty units in an hour The number of units represented by each operation must be determined by work study, and this inevitably involves the employment of skilled work-study engineers The plan is somewhat more expensive to install and administer than other schemes, and may prove complicated and difficult for workers to understand

The payment systems already described relate the award to the effort of the individual worker There are, however, many situations in industry where work is carried out by teams in which the individual efforts of each worker are conditioned by the efforts of the other members of the team To meet such situations, many forms of group incentives have been devised The major problem is to devise a method of distributing group incentive payments that will be acceptable to all the members of the group The Priestman bonus scheme is one of the more common group incentive schemes which are used in Britain It is based on the principle that, if a given number of men in a given time, when working under ordinary methods and at day-rate, are capable of producing a certain quantity and type of finished goods (called the standard output) then, if by greater collective effort without increasing the number of men or their hours of working the workers can increase this output, a percentage is added to their day-rate equivalent to that by which the standard output has been increased Group incentive schemes have three main applications in which they may be superior to individual piece-work systems .

(1) Conveyor-work where operators cannot produce any more work than is passed to them by the operators preceding them on the line of production.

(2) Work other than on conveyor where quality and handling of an operation can greatly affect the subsequent operation

(3) Work of such a varied nature, both as to kind and quantity, as to make individual measurement impracticable or excessively expensive

There is, however, a growing number of people in industrial management which holds that for several reasons, payment-by-result schemes, whether individual or group, fail to exercise the maximum possible overall incentive effect It is wrong, they argue, that all reward should be directed only towards the quantity of work produced There are many other qualities which go to make the best type of worker which may be overlooked if quantity of work is to be the sole criterion of an efficient employee

For these reasons, in recent years, a few undertakings have been seeking for a more equitable and acceptable basis of payment One method which is winning growing recognition and adoption is the individual assessment bonus scheme This starts with an arrangement to pay to every worker as a minimum the time-rates fixed by collective agreement in the industry To this is added a sum which is based on a very careful assessment of each worker in respect of a number of qualities displayed by him The qualities assessed will probably include regular attendance at work, punctual starting, saving of time, quantity of work as observed over the review period of three or six months, team work and co-operation with colleagues and supervision, personal conduct, care of the company's equipment and tools, general ability and aptitude, saving of materials and quality of work Each of the qualities selected is allotted a number of points, these being weighted in accordance with their importance The scheme presents a simple means of sharing with employees increased prosperity arising from improved performance

Great care should be taken in selection of the incentive scheme to suit the particular type of production, and the booklet gives examples of schemes which might be suitable for different types of industries Before any incentive scheme is contemplated it should be made clear that the object of incentive payment is to encourage the worker to produce his maximum output without undue fatigue

T H Hawkins

# EXPERIMENTAL AND RESEARCH STATION, CHESHUNT

## ANNUAL REPORT FOR 1948

COMMERCIAL horticulture under glass is expanding steadily, and, in spite of the growing contribution to food supplies, such intensive cultivation brings problems of culture, nutrition and disease The annual report for 1948 of the Experimental and Research Station, Cheshunt, Herts*, shows how the work of the Station has increased the yield of tomatoes and lettuce Its recent trials indicate that the English tomato Downes Seedling and the Dutch variety Bruinsma gave the highest yields, at 61 tons per acre The new Cheshunt *5B* lettuce matures eight days earlier than the Station's original introduction, Early Giant Mushrooms grown on horse manure compost yielded 1 9 lb per sq. ft against 1 2 lb for the best of a number of 'synthetic' composts. Other features of practical culture relate to the successful growing of tomatoes in cardboard boxes treated with 'Cuprinol', the lack of disparity in yield when top-dressings are given in solid or liquid form, and the use of sulphate of ammonia as the sole source of nitrogen for the tomato crop

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* Experimental and Research Station, Cheshunt Annual Report (Thirty-fourth Year), 1948 Pp 90+4 plates (Cheshunt Nursery and Market Garden Industries Development Society, Ltd , 1949 )

The severity of disease caused by the fungus *Didymella lycopersici* seems to have no relation to manurial treatment, and excesses of magnesium, boron and manganese did not appear to influence infection (P H Williams) A fascinating possibility of 'curing' plants of virus diseases has been investigated by R Howles A spray of 1 per cent tannic acid on two consecutive days reduced by 50 per cent the number of plants infected. Solanums infected with mosaic were 'cured' by exposure to a temperature of 105° F for twelve hours per day for four consecutive days These findings certainly merit further investigation. A study of the identity and life-history of leaf miners on tomato seedlings, by E R Speyer and W J Parr, shows that the fly responsible is *Liriomyza solani* A 5 per cent benzene hexachloride dust was more effective than 5 per cent DDT in destroying adult flies, but both substances can injure tomato seedlings A study of toxicity of analogues of azobenzene against red spider mite revealed no compound more effective than azobenzene itself (W H Read) Hexaethyl tetraphosphate (HETP) and tetraethyl pyrophosphate (TEPP) destroyed adult red spider mites, but not the eggs of this pest Both the last-mentioned compounds controlled aphids on carnations.

Chemical studies involve, *inter alia*, fundamental investigations into the mechanism of nitrification in glasshouse soils by O Owen and G W Winsor Experiments with added carbon show that the lower carbon/nitrogen ratio produces the higher level of nitrification The availability of alginates raises the interesting possibility of using such substances as sources of organic carbon in soil (O Owen) Alginic acid and sodium and calcium alginates have given promising results, though ammonium alginate may be almost toxic Some rather variable results of trials with calcium alginate on a commercial scale, however, show that further work on the subject is needed Changes in nitrification after steam sterilization are greatly in need of investigation, and it is gratifying to note that work on this project has commenced (J N Davies and O Owen)

A mild criticism of the report is its increase in page size from octavo to quarto, which disorganises the files. This petty complaint, however, serves but to emphasize the value of the work in the report, for he who reads it desires to preserve it for future convenient reference

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# EFFECT OF CERTAIN YEASTS ON SOME TUMOUR CELLS

CERTAIN strains of yeast apparently show *in vitro* a selectively destructive action on the cells of some malignant tumours, but not on those of benign tumours or of normal tissues. Dr Giocondo Protti, of Busto Arsizio, Italy, has been working in this field since 1930 and has developed special techniques which he has recently summarized in three articles[1].

Fragments of tissue were selected from frozen sections examined by phase-contrast microscopy to ensure that only actively growing tissue free from necrosis was used The fragments were immersed in liquid cultures of *Saccharomyces cerevisiæ* var *ellipsoideus* and incubated at 30° C for 48 hr. About a hundred varieties of yeast were tested, with variable results, certain varieties caused lysis of the nuclei of some tumours but were inactive for other tumours

Controls with inactivated yeast and with medium devoid of yeast showed that incubation alone or in the presence of certain yeast metabolites did not produce comparable lysis of tumour cells

Comparative studies on tissues incubated in contact with yeast cultures and afterwards stained with hæmatoxylin and eosin, or better, by the Feulgen technique, showed varying degrees of nuclear lysis in the case of tumour tissues These degenerative changes could be seen also by phase-contrast microscopy adenocarcinoma of the alimentary canal, the [illegible] of the malignant epithelium showed lysis, whereas the nuclei of the connective tissue and endothelial cells of blood vessels were relatively well preserved. Protti considers the Feulgen reaction a reliable indication, though not amounting to a quantitative measure, of the thymonucleic acid content of nuclei The nature of the lytic action has not been determined.

In experiments with a spontaneous mammary tumour of mice of *L*-strain, 96 tissue cultures were tested against six different strains of yeast, as compared with control tissue cultures of fibroblasts (? mouse), and of retinal epithelium of 12-day chick embryos Tumour cultures in contact with *Saccharomyces cerevisiæ* var *ellipsoideus* *E* 14 showed little difference from control cultures and developed normally By contrast, tumour cultures from the same material in contact with the following strains of *Saccharomyces*, *E* 4, *C* 35, *T* 54, *E* VIII and *D* XII, all showed arrested development and lysis of nuclei in the explants, apart from a few attempts at proliferation modified by the lytic process Neither fibroblast nor retinal epithelium cultures showed lysis

The mechanical effect of the yeast particles was controlled by the addition of inert powders, for example, talc or carborundum, in place of yeast cultures Such additions had no effect on the growth of either tumour or normal tissues in culture Altogether, 637 experiments gave similar results Three strains of yeast, *E* 4, *E* 14 and *E* VIII, showed no biochemical differences, but *E* 14 was inactive, while the other two caused lysis of tumour explant.

The lytic effects observed were quite different in appearance from necrobiotic effects on the tumour as shown by the Feulgen technique Protti considers that the selective lytic action of certain yeasts on certain tumour cells indicates a metabolic difference between tumour and normal cells In the discussion of his work he expresses the hope that his observations may eventually lead to some form of specific treatment

It might be objected that normal fibroblasts and chick embryo retinal epithelium may well have different metabolic reactions from mammary tumour or adenocarcinoma of the alimentary canal. Possibly tissue cultures of adolescent mouse mammary tissues and of the benign adenoma that frequently precedes adenocarcinoma of breast in mice would provide a better control when studying mouse mammary carcinoma

P R P

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[1] Protti, G, *Tumori*, **22**, 222 (1948), **23**, 156 (1949), **24**, 14 (1950)

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications*

## Radio-frequency Radiation from the Great Nebula in Andromeda (M.31).

THE experiments of Bolton and Stanley[1], and of Ryle and Smith[2,3], using a radio interferometer have shown that a significant part of the extra-terrestrial radio noise is associated with point sources with diameters of less than 6 minutes of arc Although the majority of these sources are unidentified with visual objects, their distribution indicates that they lie in our own galaxy Attempts to detect radio emissions from specific extra-galactic objects have hitherto been unsuccessful In this communication we describe the results of an experiment to detect radio emissions from the Andromeda Nebula (*M* 31) using a narrow pencil-beam aerial and high-sensitivity receiving equipment

The measurements were made at a frequency of 158 5 Mc /s using a paraboloid aerial with an aperture of 218 ft, and a focal length of 126 ft The beam has a width of about 2°, and by moving the primary feed it can be swung at least 15½° on either side of the zenith without serious distortion of its shape The receiving equipment employed a system in which the power from the aerial was balanced by means of a servo system against the power from a calibrated source, and was similar to that described by Ryle and Vonberg[4] The minimum detectable power corresponded to a change in effective temperature of the aerial of about 2° K This allows for a loss of 50 per cent of the aerial power in the feeder system and represents 1/1,500 of the noise in the equipment The experiment was carried out by fixing the beam at a number of different elevations corresponding to the region around *M* 31, so that for each diurnal rotation of the earth the beam swept out a strip of sky 2° wide in declination and 24 hr in right ascension The intensity of the radiation was recorded for a series of six strips at declinations between 38° N and 43° N

Fig 1 shows the results of these observations for the period 23 h 40 m to 01 h 20 m in right ascension In order to show clearly the change in intensity with right ascension along each sweep, the records have been displaced by an arbitrary amount, corresponding to different declinations, so that the ordinate represents only the relative intensities for the points in each sweep The sweeps between declinations 40° 18′ and 40° 52′ show a pronounced maximum in intensity at 00 h 40 m R A , indicating a localized source of radiation in this neighbourhood A full analysis of the results from all the sweeps, taking into account the gradient of the galactic background radiation in this region, yields the data for this source given in Table 1

Table 1 DATA ON SOURCE

| | |
|---|---|
| Right Ascension | 00 hr 40 min ± 2 min |
| Declination | 40° 55′ North ± 20′ |
| *Intensity | $4 \times 10^{-25}$ watts/sq m /c /s ± 25 per cent |
| Apparent angular dimensions | 25′ ± 10′ (declination axis) × 45′ ± 10′ (right ascension axis) |

* Calculated for an equivalent point source The error introduced by neglecting the finite size of the source is small compared with the errors of measurement

The celestial co-ordinates of this source lie close to the centre of the Andromeda Nebula *M* 31 (R A 00 h 40 m , dec 40° 59′ N ) The dimensions of the source were measured by comparison with the apparent diameter of two sources at approximately the same declination as *M* 31, thus eliminating any error due to possible distortion of the beam The diameter of one of these sources, in Cygnus, is known[1 4] to be less than 6′, which is small compared with the beam-width of 2° used in these experiments The extension of the Cygnus source on the records will therefore correspond to the width of the beam Fig 2 shows the intensity recorded for a short period of right ascension during the transit of three different sources through the beam Curve *A* shows the transit of the source in Andromeda Curve *B* shows the transit of a point source of intensity comparable to that of the Andromeda source, while curve *C* shows the transit of the intense point source in Cygnus The scale of intensity for each diagram has been adjusted so that the widths in right ascension of the records can be compared easily From these records it can be seen that the source in Andromeda shows an extension in right ascension greater than that of a point source The width of the source in declination was found by comparing its variation in intensity with declination with that of the point source in Cygnus Table 2 gives the comparison between the apparent width to half-power of the Cygnus and Andromeda sources

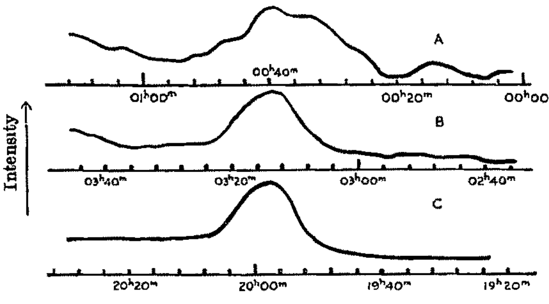

Fig 2

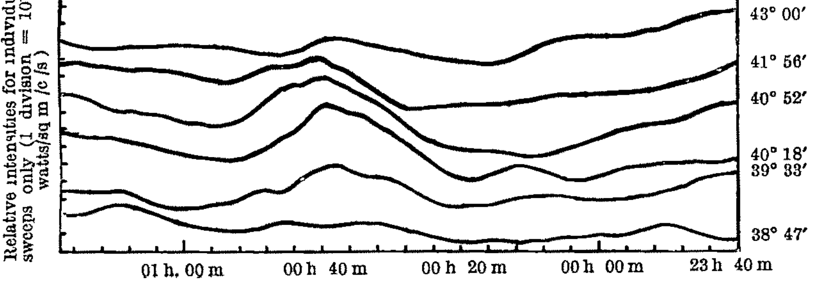

Fig 1

These records therefore show that the source must have a disk of apparent dimensions ¾° × ½° along the right ascension and declination axes respectively There is a chance that the apparent extension of the source is due to the fortuitous presence of

Table 2 APPARENT WIDTH TO HALF-POWER OF THE SOURCES IN CYGNUS AND ANDROMEDA

| | |
|---|---|
| Cygnus | 2° 04′ (declination × 1° 53′ (right ascension) |
| Andromeda | 2° 54′ (declination) × 3° 23′ (right ascension) |

two or more point sources of the appropriate intensity in the beam with their effective centre coincident with that of *M* 31 From a study of the available information about point sources, it can be shown that the chance of such a coincidence is less than 1 in 4,000

It is of interest to compare the radiation from this nebula with that to be expected from our own galaxy Inspection of the contours given by Reber[5] on 160 Mc /s , and by Bolton and Westfold[6] on 100 Mc /s , indicates that the radiation from our own galaxy is concentrated towards the centre, and at a distance of 750,000 light years with the inclination of *M* 31 it would appear as a source with apparent dimensions of about ½° × ½° along the right ascension and declination axes Also, from the measured size of the disk and the intensity of Andromeda given in Table 1, it can be calculated that the effective black-body temperature of the nebula must be of the order of 1 000° K This is to be compared with the corresponding value of 1,500° K for the centre of our local galaxy deduced from the measurements made by Reber[5] on 160 Mc /s

These measurements demonstrate with a high degree of probability that extra-galactic radio-frequency radiation is being received on the earth from the Great Nebula in Andromeda, and that, so far as radio emission is concerned, it appears to be similar to our own galaxy

This work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester The aerial system was designed by Dr J A Clegg, and we wish to thank Dr A C B Lovell for its use in this investigation. One of us (R H B ) is indebted to I C I , Ltd , for a research fellowship, and the other (C H ) to the Department of Scientific and Industrial Research for a maintenance grant

R HANBURY BROWN
C HAZARD

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Oct 13

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[1] Bolton and Stanley, *Nature*, **161**, 312 (1948), **162**, 141 (1948)

[2] Ryle and Smith, *Nature* **162**, 462 (1948)

[3] Ryle, *Phys Soc Rep Prog Phys* , **13**, 184 (1950)

[4] Ryle and Vonberg, *Proc Roy Soc* , **A**, **193**, 98 (1948)

[5] Reber, *Astrophys J* , **100**, 279 (1944)

[6] Bolton and Westfold, *Aust J Sci Res* , **3**, 19 (1950)

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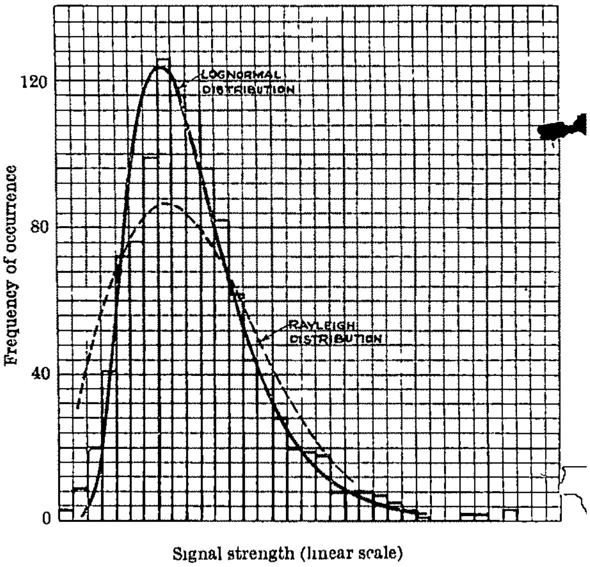
# Variability of Sky-Wave Radio Signals under Conditions of Ionospheric Absorption

AN investigation is being made into ionospheric absorption, in which the instantaneous value of signal strength of a 9 15-Mc /s radio wave at a distance of 788 km from the emitter is recorded once a minute It has been found that the usually assumed Rayleigh distribution of amplitudes[1] is a poor fit to the observed distribution at times around local noon when ionospheric absorption is considerable

The observed variations in strength of signals are much better accounted for if we assume that the absorbing region is the main controlling factor, and that the amount of absorption in this region varies randomly about a mean value Then, since the absorption at any instant is proportional to the logarithm of the signal strength $E$, the frequency distribution of signal strength values will be log-normal[2,3] in character, that is, the probability of occurrence of a value between $E$ and $(E + \delta E)$ will be given by



$$\frac{1}{\sqrt{2\pi}\,cE}\exp\left[-\frac{1}{2c^2}\left(\log_e\frac{E}{E_0}\right)^2\right]\quad\delta E,$$

where $E_0$ is the median value of the distribution, and $c^2$ is the variance of $\log_e E$ The above frequency distribution, when plotted on logarithmic probability paper, will give a straight line

Lognormal curves have been fitted to several sets of observed results One of these is reproduced in the accompanying histogram, which shows the distribution of signal strengths measured between 1115 and 1245 hr , local time, over the period June 14–30, 1949 To reduce the effects of day-to-day variations in the mean level of signal strength, and the slow diurnal variation in absorption within each day, the recordings were divided into half-hour periods, and the readings in each period were adjusted to give an average value of 20 recorder divisions The fitted lognormal curve is shown in full line, together with the fitted Rayleigh distribution (dotted) for comparison A chi-square test gave a probability of 0 39 for the lognormal fit, as against a value of less than $10^{-6}$ for the Rayleigh fit

A further comparison between the theoretical distributions is given by testing the ability of each to predict the value of signal strength, which is actually exceeded for a certain percentage of time , in particular, the 90 per cent and 95 per cent values, which are of practical significance in communication engineering The results are shown in the accompanying table

| Percentage of time signal strength is exceeded | Differences in decibels | |
|---|---|---|
| | Lognormal–actual | Rayleigh–actual |
| 5 | 0 | +0 3 |
| 10 | −0 1 | +0 3 |
| 25 | 0 | +0 6 |
| 75 | −0 2 | −1 2 |
| 90 | +0 6 | −2 5 |
| 95 | +1 1 | −3 6 |

From this table it is seen that the lognormal distribution gives a better estimate of all percentiles listed. For example, if we used the Rayleigh distribution to predict the 95 per cent value, the estimated emitter power would be more than twice that actually required to maintain communication.

This work forms part of the radio research programme of the Department of Scientific and Industrial Research, New Zealand, and it is reported with the permission of the Secretary of the Department. A full account of the investigation will be published elsewhere.

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[1] See, for example "Ionospheric Radio Propagation" (National Bureau of Standards Circular 462, Washington, 1948).

[2] McAllister, *Proc. Roy. Soc.*, **29**, 367 (1879).

[3] Yuan, *Ann. Math. Stats.*, **4**, 30 (1933).

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## High-Current Gas Discharge at Low Pressures

It has been found that the self-magnetic field associated with the flow of current in a low-pressure discharge (mercury vapour at less than $2 \times 10^{-3}$ mm pressure) plays an important part in determining the radial density distribution at currents as low as 30 amp. The effect of this magnetic field can be treated by adding a 'magnetic potential' term $V_m = \int_0^r \bar{w}_1 H dr$ to the electrostatic potential $V_s$ in the Boltzmann equation, $\bar{w}_1$ being the longitudinal electron-drift velocity. The drift of electrons and ions to the tube walls is equalized at low arc currents by a radial electric field. Since the self-magnetic field tends to reduce the drift of electrons to the walls while having a negligible influence on the positive ions, increasing the arc current leads to a progressive reduction in the radial electric field.

Probe measurements in a mercury-vapour arc tube (diameter 54 mm.) at pressures less than $10^{-3}$ mm. show that at currents greater than 50 amp. the radial electric field $E_s$ is negligible compared to the term $\bar{w}_1 H$ except close to the tube walls. With the assumption that $E_s$ may be neglected, the three equations yielding the electron density distribution are

$$n_1 = n_{10} \exp\left[\frac{-e_1 V_m}{kT_1}\right] \tag{1}$$

$$V_m = \int_0^r \bar{w}_1 H dr, \tag{2}$$

$$H = \frac{2J}{r} = \frac{4\pi}{r}\int_0^r n_1 e_1 \bar{w}_1 r dr \tag{3}$$

The solution found is

$$\frac{n_1}{n_{10}} = \left[\frac{1}{1 + A\frac{r^2}{r_0^2}}\right]^2 \tag{4}$$

where $A = \dfrac{\frac{1}{2}J_a e_1 \bar{w}_1}{kT_1 - \frac{1}{2}J_a e_1 \bar{w}_1}$,

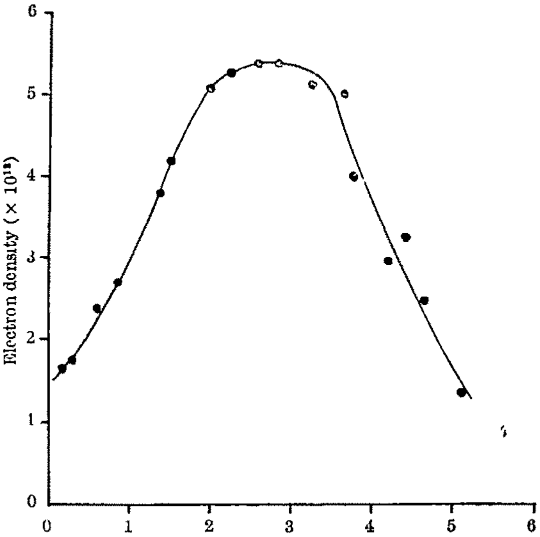

Fig. 1. Radial electron density distribution. Discharge current, 150 amp., mercury vapour pressure corresponding to 19.5° C., $\bar{w}_1 = 1.5 \times 10^7$ cm./sec., electron temperature, 31,500° K.

In practical units, $$A = \frac{J_a \bar{w}_1}{2 \times 10^9 V_1 - J_a \bar{w}_1}, \tag{5}$$

where $J_a$ is the arc current in amp., $\bar{w}_1$ is in cm./sec., $V_1$ in volts, $r$ in cm. and $V_1 = kT_1/e_1$.

The axial electron density is given by

$$n_{10} = \frac{1.99 \times 10^{18} J_a}{\bar{w}_1 r_0^2\left(1 - 5 \times 10^{-10}\frac{J_a \bar{w}_1}{V_1}\right)}. \tag{6}$$

It is interesting to note that as $J_a \bar{w}_1 \rightarrow 2 \times 10^9 V_1$, $n_{10} \rightarrow \infty$, suggesting that the arc tends to contract into a narrow channel. This behaviour may be compared with that termed by Tonks[1] the 'pinch effect'. Fig. 1 illustrates the electron-density as a function of tube radius under conditions where the arc is beginning to constrict. If the discharge is to remain stable, this tendency must change in the neighbourhood of the critical current. At sufficiently high currents the degree of ionization becomes appreciable, and both $\bar{w}_1$ and $V_1$ tend to increase with current; thus it is not possible to decide whether instability occurs without a more detailed analysis.

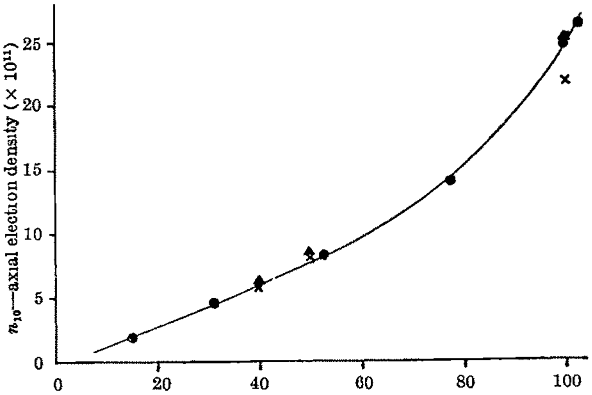

Fig. 2. Comparison of measured and calculated axial electron densities. ●—●—, density from probe measurements; ▲—▲—, density computed from eq. (7); ×—×—, density computed from eq. (6). Mercury vapour pressure corresponding to 10° C.

The results quoted above are derived on the assumption that the electrons are in strict equilibrium with the fields, that is, no radial electron flow. In fact, there is always a generation of ions and electrons and a constant radial flow of momentum towards the tube walls. The ions, which are responsible for the greater part of the radial momentum flow, acquire this predominantly in the ion sheath at the tube walls. By considering the discharge divided into two regions—(1) in the plasma where $H\bar{w}_1 > E_s$ and (2) in the sheath where $E_s > H\bar{w}_1$—a correction can be applied to equation (6) to give the axial electron density in the steady-state case. This is

$$n_{10} = 3\;21 \times 10^{11} \frac{I_{2w}}{V_1^{1/2}} \left[\frac{2 \times 10^9 V_1}{2 \times 10^9 V_1 - J_a\bar{w}_1}\right]^2, \qquad (7)$$

where $I_{2w}$ is the positive ion current to the walls in milliamp/cm$^{2}$.

Fig. 2 shows a comparison between the measured axial electron density and that computed from equations (6) and (7). At the higher currents the relationship between $J_a$ and $n_{10}$ departs markedly from the linear one found at low currents.

It might be expected that at still greater currents the axis of the arc could become negative with respect to the surrounding plasma. This reversal would be too small to influence appreciably the radial-density distribution unless the ions gain energies comparable with the electron energies. The life of a positive ion is generally too short to acquire any appreciable energy by electron-ion collisions or by collisions of the second kind.

It is believed that the assumption $E_s = 0$ is justifiable over a wide range of currents, and in this range the self-magnetic field is the most important factor determining the electron density.

A detailed report of this work is to be published shortly.

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[1] Tonks, L., *Phys. Rev.*, 56, 360 (1939).

## Grain Boundaries and Sintering

IN the course of a study of thermal etching, some experiments were carried out on specimens cut from cold-rolled, high-purity silver sheet containing a number of uniformly distributed blow-holes. A flat, electrolytically polished surface was prepared on each specimen, which was then annealed for 19 hr. at 900° C. in oxygen-free nitrogen. Fig. 1 shows the appearance of a section through a specimen which has been subject to this treatment. The grain boundaries have been revealed in the section by thermal etching.

It was noticed that in the annealed specimens most of the blow-holes lay in the planes of the grain boundaries, and it was also apparent that the large number of small blow-holes in the original material had been replaced by a smaller number of larger holes of nearly uniform size. It seemed that, as grain growth was taking place after the initial recrystallization, the grain boundaries moving through the material swept up all the blow-holes in their path, the holes afterwards migrating with the boundaries.

The increase in size of the blow-holes can easily be explained in terms of the free energy of the system. If two small blow-holes unite to produce one large hole, the total surface area, and hence the total free energy of the system, decreases. Similarly, when a bubble passes from the interior of the grain to a grain boundary, an area of grain boundary corresponding to the cross-section of the bubble is destroyed. Since the surface area of the bubble remains constant, free energy corresponding to the area of boundary destroyed is liberated when the boundary meets the bubble. Similarly, free energy is required to move the boundary away from the bubble. The bubble is thus likely to move with the advancing boundary. But, as can be seen from Fig. 1, some of the bubbles must have moved a considerable distance with the grain boundaries. Some mechanism must be moving material from one side of the bubble to the other at quite a high rate. It seems possible that surface migration is responsible for this. A difference in free energy, such as a difference in strain energy, between the two crystals forming the grain boundary would then also provide a driving force to move the bubbles.

In studies of the elimination of isolated pores from a solid body—the second stage of sintering—it is usual to consider that the pores are uniformly distributed throughout the body (see, for example, Mackenzie and Shuttleworth[1]). In view of the observations recorded here, this assumption does not seem to be generally justified, and its use may be misleading. A plastic flow mechanism, for example, would cause a much more rapid increase in density of a body containing pores distributed in planes than of a second body containing the same pores randomly distributed.

The initially flat, polished surface of the sheet containing blow-holes would frequently show large grooves, sometimes associated with steps, after the first annealing process. Fig. 2 shows such a step. The annealed specimen has been plated with copper, and then a section taken normal to the prepared surface. These grooves are much larger than those formed on heating a specimen free from blow-holes under the same conditions. It is difficult to see how these features could develop without the transference of holes from the outer layers of the metal to the surface itself. This could take place if a grain boundary associated with holes were moving into the surface

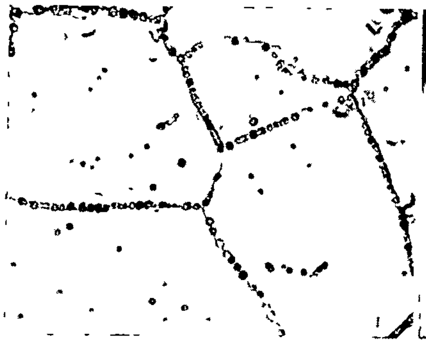

Fig. 1. Section through annealed surface (× 75)

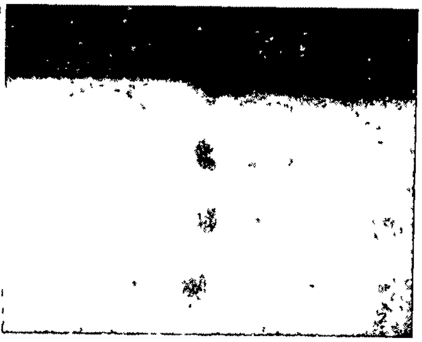

Fig. 2. Step in annealed surface (× 250)

of the specimen, or if the holes could move towards the surface in the plane of the grain boundary either bodily or as vacant lattice sites Such processes would lead to the increase in density of the surface layers of the specimen if the final grain size were small compared with the size of the specimen

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this note

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July 6

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[1] Mackenzie, J K , and Shuttleworth, R , *Proc Phys Soc* 62B, 833 (1949)

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## Viscosity of Liquids at High Rates of Shear

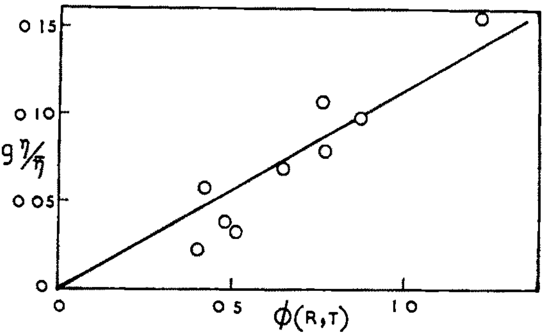
While it is well established that solutions of macro-molecular substances may show an anomalous fall in the coefficient of viscosity at high rates of shear, there is much conflict in the experimental evidence relating to the behaviour in this respect of ordinary lubricating oils It was suggested by Grunberg and Nissan[1] that at high rates of shear the viscosity of ordinarily 'Newtonian' liquids might become a function of the rate of shear They developed an equation to account theoretically for this dependence, and calculated that for *n*-pentane at 30° C the viscosity should fall sharply over a range of the rate of shear from about $10^8$ to $10^{11}$ $\sec^{-1}$

In experimental measurements it is difficult to keep the temperature constant, since at high rates of shear a considerable amount of heat is developed Under these conditions, the effect of a rise in temperature is twofold There is the normal decrease in viscosity found with all liquids, and in addition the extent of the anomaly in viscosity caused by the high rate of shear is less at high temperatures This latter effect of temperature may be estimated from the equation of Grunberg and Nissan It is now possible to test their theory with some measurements (with a high-speed rotational viscometer) of the viscosity at high rates of shear of a mineral oil which conformed to the S A E 30 specification (to be published in full elsewhere) It was found that the anomalous fall in viscosity increased with the rate of shear (for values up to about $2 \times 10^5$ $\sec^{-1}$), but a rise in temperature produced a very marked decrease in the anomalous fall in viscosity

The extent of the anomaly may be represented by the ratio ($\eta/\bar{\eta}$) of the normal viscosity to the viscosity, at the same temperature, for the high rate of shear For the present experimental conditions the theory of Grunberg and Nissan predicts very nearly a linear relationship between log $\eta/\bar{\eta}$ and

$$\frac{R\eta}{T^2}\quad\frac{1}{1 + R\eta/1\ 103 \times 10^4 T} = \varphi\,(R,T)$$

where $R$ is the rate of shear ($\sec^{-1}$) and $T$ is the absolute temperature The experimental results are plotted in this way (see graph) It is seen that there is reasonable agreement with the theory, considering that the points correspond to a very wide range of experimental conditions Although there is some scatter about the straight line, the correlation coefficient between log $\eta/\bar{\eta}$ and $\varphi(R,T)$ has the high value of 0 85, which is significant at the probability level of 0 002



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[1] Grunberg, L , and Nissan, A H , *Nature*, 156 241 (1945)

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## Viscosity-Temperature Dependence

The relationship between $\eta$, the viscosity of a liquid at a temperature $T$, and $E_v$, the activation energy of viscous flow, has been expressed by

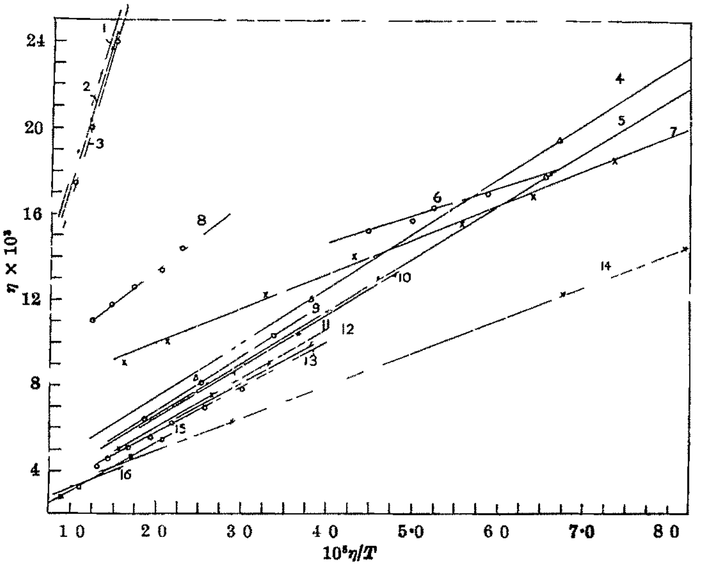
$$\eta = A \exp E_v/RT \tag{1}$$
$$\text{or}\ \log \eta = E_v/RT + \text{constant} \tag{1a}$$

Equation 1*a* implies that a linear relationship exists between log $\eta$ and $1/T$ In many cases investigated, however, the straight lines obtained when log $\eta$ is plotted against $1/T$ are parts of curves extending over wide ranges of temperature

In the case of petroleum oils, the A S T M chart, or an equation of the form,

$$\text{loglog}\ (\nu + c) = A_1 \log T + B,$$

where $\nu$ is in centistokes, is extensively used, but convex and concave deviations from the implied



| Liquid | Viscosity range ($\eta$ poises × $10^3$) | Temperature range (° C.) | $\frac{\eta}{T}$ ($10^5$) range |
|---|---|---|---|
| 1 96.5 Fe 3.5 C | 29.0 to 17.5 | 1,250 to 1,400 | 1.9 to 1.0 |
| 2 97.0 Fe 3.0 C | 28.0 ,, 20.3 | 1,300 ,, 1,400 | 1.8 ,, 1.2 |
| 3 97.5 Fe 2.5 C | 26.5 ,, 22.5 | 1,350 ,, 1,400 | 1.6 ,, 1.3 |
| 4 Formic acid | 23.9 ,, 5.58 | 7.6 ,, 97.2 | 8.5 ,, 1.5 |
| 5 Water | 26.0 ,, 2.83 | −10 ,, 70 | 9.9 ,, 1.2 |
| 6 Ethyl alcohol | 17.9 ,, 15.4 | 0 ,, 70 | 6.6 ,, 4.5 |
| 7 Mercury | 18.6 ,, 9.3 | −20 ,, 300 | 7.3 ,, 1.6 |
| 8 Cadmium | 14.4 ,, 11.0 | 349 ,, 603 | 2.3 ,, 1.3 |
| 9 Acetic acid | 10.3 ,, 4.4 | 30 ,, 103 | 3.4 ,, 1.2 |
| 10 Carbon tetrachloride | 13.3 ,, 5.0 | 0.6 ,, 74 | 4.8 ,, 1.5 |
| 11 Benzene | 9.0 ,, 3.5 | 0 ,, 70 | 3.3 ,, 1.0 |
| 12 Methyl alcohol | 8.1 ,, 3.5 | 0 ,, 60 | 3.0 ,, 1.0 |
| 13 Chloroform | 7.9 ,, 4.2 | −10 ,, 50 | 3.0 ,, 1.3 |
| 14 Ethyl ether | 25.7 ,, 1.9 | −110 ,, 40 | 15.7 ,, 0.6 |
| 15 *n*-Heptane | 4.8 ,, 2.1 | 6.4 ,, 92.2 | 1.7 ,, 0.6 |
| 16 Carbon disulphide | 4.3 ,, 3.1 | 0.4 ,, 45.9 | 1.6 ,, 0.9 |
| 17 **p*-Xylene | 7.5 ,, 2.3 | 8.3 ,, 135.2 | 2.8 ,, 0.6 |
|  | Poises |  | $(\eta/T)$ |
| 18 *Synthetic oils | 29,310 to 38.5 | −30 to 61 | 120 to 0.1 |
| 19 *Baku bitumens | 21,210 ,, 25.5 | 40.0 ,, 100 | 67.6 ,, 0.07 |
| 20 *Molasses | 109.7 ,, 5.4 | 70 ,, 120 | 0.3 ,, 0.01 |

* Not shown in the diagram.

straight line appear, particularly at low temperatures[1], and in the case of the polyglycols, polymethylsiloxanes, halocarbons and 'Ucon' fluids[2]. These deviations have been variously explained at low temperatures by thixotropy, and at high temperatures by thermal agitation, loss of hydrated water, and statistical uncoiling of long-chain molecules. While such effects may occur, some of the explanations appear speculative.

It cannot be concluded that existing methods of representing viscosity temperature data are entirely satisfactory, particularly over the extended ranges of temperatures modern usage encounters.

From the form of the viscosity-temperature curve of a liquid it was suspected that a simple equation would apply, of the type

$$\eta\,(1 - a/T) = b \qquad (2)$$

$$\text{or } \eta = a\eta/T + b, \qquad (2a)$$

where $\eta$ is in poises; $a$ and $b$ are constants.

Equation 2*a* has been investigated for the miscellaneous liquids given in the accompanying table. In the graph, $\eta$ has been plotted against $\eta/T$ and, as may be seen, the linear relationship holds over the temperature-ranges recorded. In the region of the boiling points, deviations appeared; but not at low temperatures, where thixotropic effects have been reported.

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Sept. 1.

[1] Ramaiya, K. S., Symp. on Visc. of Liquids and Colloidal Solutions, Acad. Sci. U.S.S.R., 2, 178 (1944).

[2] Murphy, C. M., Romans, J. B., and Zisman, W. A., *Trans. Amer. Soc. Mech. Eng.*, **71**, 561 (1949).

## The Spin and Magnetic Moment of the Rhodium Nucleus

NATURALLY occurring rhodium consists almost entirely of one isotope, ${}_{45}\mathrm{Rh}^{103}$. No hyperfine structure has previously been found, nor has a determination of the nuclear spin by any other method been made. By passing light from a hollow-cathode tube containing rhodium through an atomic beam of rhodium, we were able to observe absorption in one of the resonance lines, 3434.90 A. ($4d^85s\ {}^4F_{9/2} - 4d^85p\ {}^4G_{11/2}$)[1]. The absorption spectrum shows a well-resolved doublet, of splitting 0.023 cm.$^{-1}$. This proves conclusively that the nuclear spin has the value $I = \frac{1}{2}$, since any other value would produce a quartet or higher multiplet. The splitting of the line must be attributed to the ground-term, which contains an unpaired *s*-electron. If perfect Russell–Saunders coupling is assumed, the value of the magnetic moment can be calculated by means of the conventional approximation methods. It was found to be − 0.11 nuclear magnetons. This is one of the smallest magnetic moments so far reported.

The negative sign is not quite certain. It is derived from the observation that the component of shorter wave-length appears to be the stronger. We are attempting to confirm this by further experiments.

From the theory of shell structure, Goeppert-Mayer[2] predicts a spin of either $\frac{1}{2}$ or 9/2 for the rhodium nucleus. Feenberg and Hammack[3] expect a spin of 7/2 or 9/2, arising from the configuration $(5g)^{2n+1}$, for the ground-state, and a spin of $\frac{1}{2}$, arising from the configuration $(5g)^{2n}(2s)^1$, for the metastable state. Since, according to our experiments, the ground-term has the spin $\frac{1}{2}$, the latter assignments of configurations should be interchanged.

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Oxford. July 24.

[1] Meggers, W. F., and Kiess, C. C., *J. Opt. Soc. Amer.*, **12**, 417 (1926).

[2] Mayer, M. G., *Phys. Rev.*, **78**, 16 (1950).

[3] Feenberg, E., and Hammack, K. C., *Phys. Rev.*, **75**, 1877 (1949).

## Distribution of Range-finding Errors

THE optical range-finder measures range by what is ultimately a visual estimation of the angle subtended by its base at the target. Thus

$$R = \frac{b}{\theta}, \quad \delta R \simeq -\frac{R^2}{b}\,\delta\theta \qquad (1)$$

Consequently, for a given type of instrument the customary measure of error used is $\delta R/R^2$. This will be approximately proportional to $\delta\theta$ and can be used for combining or comparing errors of measurements on targets at different ranges.

In some recent trials a considerable number of estimates of ranges to targets at accurately surveyed distances was made. The frequency distribution of errors expressed in the form

$$y = \text{range error}/(\text{true range})^2$$

departed significantly from the normal form. More unexpectedly, it showed significant skewness, there being a marked excess of large positive errors. The accompanying table compares observed percentages with those expected on the basis of a normal distribution.

While the distribution of errors in visual measurements of angle is probably far from normal, there is every reason to expect it to be symmetrical. The reason for the skewness observed lies in the approximation used in (1). This approximation implies that range errors of equal magnitude will result from angular errors of the same size but of opposite signs

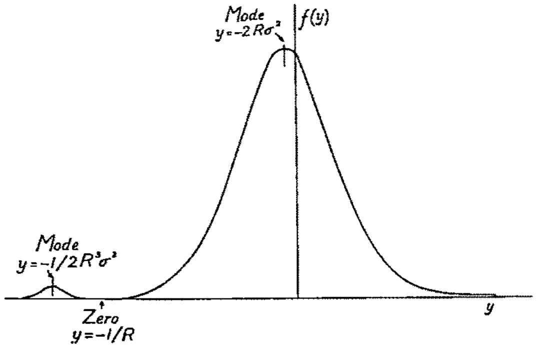
| Size of zone | ± 19 units | ± 46 units | ± 72 units |
|---|---|---|---|
| % inside zone on normal theory | 50 per cent | 90 per cent | 99 per cent |
| % of observations inside | 57 ,, | 89 ,, | 96 ,, |
| % of observations outside (above) | 22 ,, | 7 ,, | 3 ,, |
| % of observations outside (below) | 21 ,, | 4 ,, | 1 ,, |

In fact, the positive change in range due to replacing $\theta$ by $(\theta - \varepsilon)$ is greater numerically than that due to using $(\theta + \varepsilon)$

Assuming a normal distribution of angular errors of standard deviation $b\sigma$, the frequency function of the measure of error $y$ will be

$$\frac{1}{\sqrt{2\pi}\,\sigma\,(1+Ry)^2}\cdot\exp\left[\frac{-y^2}{2\ {}^2\,(1+Ry)^2}\right]$$

The general behaviour of this function is illustrated by the accompanying graph, which is not to scale



The approximation used in (1) is equivalent to disregarding the term $Ry$ at the appropriate places In the practical application $R$ was of the order $10^3$ and $\sigma$ of the order $10^{-5}$ Consequently, values of $|Ry|$ greater than 0 03 will scarcely ever arise For small $R\sigma$, the proportions of readings outside the limits $\pm k\sigma$ will be

$$\int_k^\infty \frac{1}{\sqrt{2\pi}}\exp\left(\frac{-x^2}{2}\right)dx \pm \frac{R\sigma k^2}{\sqrt{2\pi}}\exp\left(-\frac{k^2}{2}\right)$$

In order to check the above explanation the errors were expressed in the form

range error/true range × observed range

This expression is exactly proportional to the angular error, and the resulting distribution was found to be symmetrical, though still not normal

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## Static Meson Potentials and the Deuteron Problem

THE static potential of interaction between two nucleons predicted by meson theory[1] has the general form

$$\left(J + F\mathfrak{D}\,r\,\frac{d}{dr}\,\frac{1}{r}\,\frac{d}{dr}\right)\varphi(r)\,,$$

$\varphi(r)$ is here the Yukawa central potential, $\mathfrak{D}$ the dipole axial operator, $J$ and $F$ two constants depending on the source parameters The $r^{-3}$ singularity of this potential must be removed by some arbitrary cut-off procedure We have investigated the ground-state solution of the deuteron equations for such a potential, using the 'zero cut-off' introduced by Bethe[2], for the two values 225 $m$ and 284 $m$ of the meson mass, and a number of numerical values of the constants $J$ and $F$ In each case the value 2 24 MeV of the binding energy of the deuteron was assumed, and the amount $P$ of $D$-state, the quadrupole moment $Q$ and the cut-off radius $r_c$ were determined

It is found that the best experimental values $P_0 = 0\ 04$ and $Q_0 = 2\ 73 \times 10^{-27}$ cm $^2$ are obtained for the following values of the potential constants

For the mass 225

$$J = 28\text{ MeV}\ ,\quad F = 14\text{ MeV} = \tfrac{1}{2}J\,,\quad r_c = \tfrac{1}{2}r_0\,,$$

For the mass 284

$$J = 53\text{ MeV}\ ,\quad F = 35\text{ MeV} = \tfrac{2}{3}J\,,\quad r_c = \tfrac{3}{4}r_0\,,$$

where $r_0$ is the range of the nuclear forces Thus, the ratios $F/J$ and $r_c/r_0$ are comparable and both increase with the meson mass, the magnitude of the former shows that the axial dipole coupling is 'large' Further, the sign of $J$ indicates that the central potential gives rise to an attraction in the ground-state

The calculations made with several other pairs $(J,F)$ give us an idea of the relations between these constants and the values of $P$, $Q$ and $r_c$. For example, we find that

(1) For $Q = Q_0$, $P$ increases with decreasing $J$, in particular, a repulsive potential would clearly give too high an amount of $D$-state

(2) For the right value of $F$, the value of $Q$ is practically independent of $J$ or $P$, when

$$3 \text{ per cent} \leqslant P \leqslant 5 \text{ per cent}$$

(3) For the right value of $J$, the ratio $Q/P$ is practically independent of $F$, when

$$0 \leqslant P \leqslant 5 \text{ per cent}$$

These last two properties hold more accurately for the mass 284 than for the mass 225

On the other hand, for the meson mass 284, one finds[3] for the value ${}^3J^{(0)}$ of $J$ for a purely central meson potential $(F = 0)$

$${}^3J^{(0)} = 53\ 2\text{ MeV}\,,$$

which is surprisingly near the corresponding value of $J$ for the non-central potential This means that the large axial dipole coupling has only a very small effect on the binding energy The value ${}^1J^{(0)}$ of $J$ in the singlet $S$-state is[4]

$${}^1J^{(0)} = 34\ 9\text{ MeV}$$

The fact that this value is equal to that of $F$ is probably fortuitous These numerical coincidences occur only for mass values about 284

A further discussion shows that it is not possible to get the right pair $(J,F)$ with any theory involving only one kind of meson field Thus we have to adopt a mixture of fields, for example, a mixture of pseudoscalar and vector fields[5] (Our method does not allow us to choose a theory with fields of different masses ) For the mass 284, the pseudoscalar-vector theory leads to the following equations for the source parameters

$$\text{vector field}\ \begin{cases} g_1{}^2 - \mu g_1 g_2 = 0\ 031\ \hbar c = 4\ 2\,e^2\,, \\ g_2{}^2 - \mu g_1 g_2 = 0\ 064\ \hbar c = 8\ 8\,e^2\,, \end{cases}$$

$$\text{pseudoscalar field}\quad f_2{}^2 + \mu f_1 f_2 = 0\ 144\ \hbar c = 19\ 7\,e^2\,,$$

$\mu$ is the ratio of the meson to the proton mass

The first of these two biquadratic systems has two pairs of solutions

$$\text{for } g_1 g_2 \text{ positive} \quad \begin{cases} g_1{}^2 = 0\ 039\ \hbar c = 5\ 3\ e^2 \\ g_2{}^2 = 0\ 072\ \hbar c = 9\ 9\ e^2 \end{cases}$$

$$\text{for } g_1 g_2 \text{ negative} \quad \begin{cases} g_1{}^2 = 0\ 025\ \hbar c = 3\ 4\ e^2 \\ g_2{}^2 = 0\ 058\ \hbar c = 7\ 9\ e^2 \end{cases}$$

I am indebted to Prof L Rosenfeld for a stimulating correspondence and fruitful discussions

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du Congo Belge,
Léopoldville
July 5

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## Acarine Growth : a New Ecdysial Mechanism

THE cyclic growth and metamorphosis of members of the Acarina have been neglected as a field for embryological research, the primary reason probably being the difficulty of devising rearing arrangements which would provide individuals at known phases of growth and development , moreover, the minute size of most of these animals, and the relatively large surface area of strongly sclerotized cuticle, have probably been responsible for abortive attempts to make the required histological investigations

The essential stages of acarine growth are the hexapod larva, the nymph and the adult, with interposed transition stages which may conveniently be termed the pre-nymph and the pre-adult There are deviations from the normal course , for example, the Tyroglyphid mite has two nymphal instars with usually the spasmodic production of the peculiar hypopus between them , the Oribatid mite has three nymphal instars , and the Trombiculid mite (harvest mite) has one only Furthermore, the differences in development within the Acarina are as interesting as those we associate with hemi- and holo-metabolous insects

The Tyroglyphid and Oribatid mites during the early developmental phase cast the old cuticle as a prelude to the retraction of the epidermis, and the new individual develops within the cast cuticle of the preceding stage The growth and development of the harvest mite, *Trombicula autumnalis*, are more complex The old cuticle is cast , but when the contained organism has reached the stage of having produced well-developed appendages, the newly formed cuticle is cast, so that the developing organism is now enclosed by the outer cuticle of the previous stage and a second or intermediate cuticle This intermediate cuticle is thin , it is homologous with the "apoderma" of Henking[1], and the "Zwischenhaut" of Claparède[2], and corresponds to the deutoval membrane of the egg The transition stages of the harvest mite therefore closely resemble the insect pupa while those of the Tyroglyphid and Oribatid mites are accompanied by a typical ecdysis In fact, it would be possible to classify mites according to the type of development , the presence or absence of puparium formation during post-embryonic growth distinguishing the two basic groups

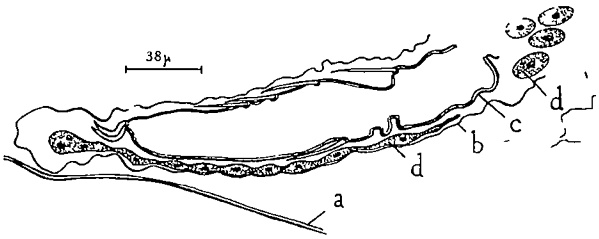

Fig 1 Section of the pre-nymphal stage of *T autumnalis* *a*, larval cuticle , *b*, intermediate cuticle , *c*, nymphal cuticle , *d*, intermediate cells

When the insect cuticle is cast it separates cleanly from the epidermis For at least those members of the Acarina which I have investigated, this ecdysial mechanism does not hold The epidermis in the case of the harvest mite and the Oribatid mite first dedifferentiates, and most of the basophil nuclei and ejected chromatin material are arranged along the inner region , but the outer region is transformed into a distinct layer of flattened cells, each with a single nucleus and non-granular acidophil cytoplasm (Figs 2*A* and *B*) Of the two layers of the epidermis the outer one, still more or less attached to the cuticle, separates from the inner layer, which retracts before eventually laying down the new cuticle The intermediate cells of *T autumnalis*, which lie between the two cuticles (Fig 1), are homologous with the isolated cells noted in *Trombidium fuliginosum* by Henking[1], and the ' hæmamœbæ" of *Atax bonzi* observed by Claparède[2] Both these authors failed to understand the significance of the cells, and their indefinite speculations with respect to the origin and function of these cells have only led to confusion

When the cuticle is cast, the endocuticle first undergoes dissolution, and it is significant that intact intermediate cells are still contiguous with the undigested exuvium and they even migrate very slightly into it , but whereas the cytoplasm of these cells is uniform when they are first cast off, it becomes intensely vacuolated after the marked dissolution of the cuticle, which further suggests that these intermediate cells are associated with the dissolution of the cast cuticle (Fig 2*B*)

In view of the nature of this ecdysial mechanism, described above, it is interesting to note that in the decapod crustacea, Yonge[3] observed nuclei in the

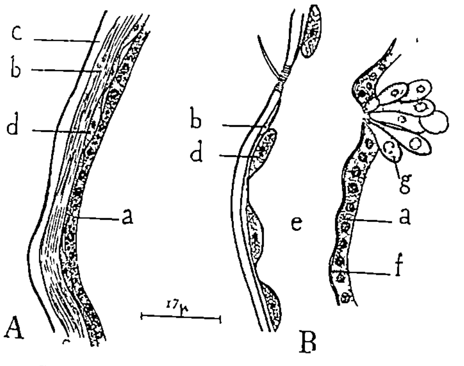

Fig 2 Sections of pre-adult transition stages of an Oribatid mite *A*, Early differentiating phase showing the epidermal split , *B*, late differentiating phase showing the cast cuticle with the intermediate cells adhering to it *a*, epidermis , *b*, endocuticle , *c*, sclerotized exocuticle , *d*, intermediate cells , *e*, exuvial cavity , *f*, newly secreted adult cuticle , *g*, dermal gland cell

exuvial cavity during the casting of the old cuticle of the œsophagus of *Homarus*; although he was unable either to distinguish the cytoplasmic components of these nuclei, or to discover their origin, he suggested they played a part in softening the 'chitin' (endocuticle) of the exuvium. Browning[4], who investigated the moulting process of the spider, *Tegenaria atrica*, came to the conclusion that the cells found in the exuvial cavity were discarded 'granulocytes', which had functioned at the previous moult in laying down the new 'exocuticula', and his findings give no reason to suppose that the ecdysial mechanism of spiders is similar to that of the closely related mites.

A former suggestion that certain glands in insects secrete the chitinase and protease in the moulting fluid[5] has given way to doubt, since they are now thought to be concerned with the production of the cement layer of the epicuticle[6]. In the mites I have studied there has been no evidence of the presence of 'moulting glands', and since the intermediate cells, of epidermal origin, are associated with the dissolution of the cuticle, it is legitimate to conclude that the process in mites is more in line with the view that the enzymes are secreted by the general epidermis. Occasionally, the intermediate cells lie, without apparent effect, upon the newly formed cuticle, and since in the harvest mite even the epicuticular exuvium appears to be soluble in the secretion produced prior to emergence, I am inclined to the view that resistance of cuticle to dissolution depends upon its viability rather than upon the mechanical protection of an epicuticle.

This ecdysial mechanism, which so far as can be found is an original observation for mites, is one of many characteristic features of histological differentiation associated with acarine growth, the morphogenetic mechanisms of which I have been investigating for the past few years, and the results of which I hope to publish elsewhere.

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July 4.

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## Protection against Aphids by Seed Treatment

IN 1948, Schrader[1] reported the discovery by himself and Kukenthal of the systemic insecticidal properties of *bis*(*bis*dimethylamino phosphonous) anhydride $[(CH_3)_2N]_2PO.O.PO[(CH_3)_2N]_2$. Since then a number of papers on the biological activity of this substance has been published, the most comprehensive from the practical control angle being the one by Ripper *et al.*[2] giving full results of field trials against hop aphids.

The present communication describes results obtained with a new technique of protecting certain plants from aphid attack. By soaking the seeds in an aqueous solution of *bis*(*bis*dimethylamino phosphonous) anhydride the establishment of aphids and red spider on the plants grown from them is prevented for a considerable time (more than fifty days under the experimental conditions employed). The treatment is prophylactic rather than chemotherapeutic, the latter term being rightly applicable only to the cure of an attack by pest or disease after its establishment.

The treatment[3] is simple and economical in manpower and materials. It does not require elaborate apparatus and, at the level suggested, has no phytocidal effect. It may therefore have practical application in the control of aphids and other insects on suitable plants, provided the seed is large enough to allow for the absorption of sufficient of the active principle.

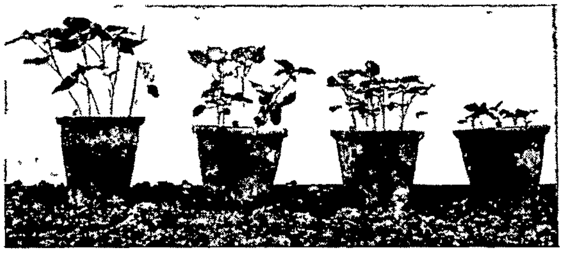
In a typical experiment, some broad bean seeds were weighed individually (average weight 2.57 gm.) and five seeds at a time soaked in an aqueous solution of *bis*(*bis*dimethylamino phosphonous) anhydride. The strength of the solution ranged from 0.016 to 0.5 per cent. After 24 hr., when the average increase in weight of the seeds was 108.5 per cent, the seeds were re-weighed and each planted in a new earthenware pot containing about 300 gm. of soil. Chemical analysis of the remaining solution showed that the phosphorus content had increased by amounts varying from 25 to 50 per cent, suggesting that the seed does not take up the active principle in the same proportions as water. At the intervals after germination stated in the table, 50–100 *Macrosiphum pisi* (Kalt.) of all stages were shaken on each plant, which was then enclosed in a cheese-cloth bag. Mortality counts were taken after 24 hr.

| Active principle in soaking solution (per cent) | % aphids dead | | | days after germination | | | | |
|---|---|---|---|---|---|---|---|---|
| | 9 | 14 | 22 | 26 | 36 | 43 | 53 | 60 |
| 0.5 | 100 | 99 | 97 | 93 | 85 | 30 | 27 | 17 |
| 0.128 | 99 | 94 | 39 | 56 | 33 | 7 | 17 | 5 |
| 0.064 | 95 | 63 | 34 | 31 | 22 | 5 | 18 | — |
| 0.032 | 77 | 9 | 12 | 13 | 25 | 3 | 7 | — |
| 0.016 | 15 | 5 | 10 | 7 | 4 | 2 | 5 | — |
| Control | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 |

Even at the highest strength, after 53 days the mortality 24 hr. after re-infestation was low (27 per cent); however, it increased to 73 per cent within 72 hr. Thus, soaking the seed with a 0.5 per cent solution of the chemical gave protection to the plant for more than fifty days. After the sixtieth day, toxicity was almost lost. In other experiments, the seeds were allowed to dry after soaking; they retained their insecticidal properties at subsequent planting. Soaking with 1 per cent solution gave no phytotoxic effect; but 2 per cent gave a significant decrease in the germination-rate and stunting of the plants which developed.

Some experiments with aphids confined on individual leaves showed that toxicity is first lost among the younger leaves at the top. The chemical is therefore not evenly distributed in the plant but tends to remain in those parts where it was originally translocated from the cotyledons. After the latter are used up, newly laid-down plant tissue will decrease in toxicity.

The accompanying photograph shows the results of an experiment with cotton under greenhouse conditions. Reading from left to right, the pots contain plants from seed soaked with 2.0, 1.0, 0.5 and 0 per cent *bis*(*bis*dimethylamino phosphonous) anhydride in water. The plants were seven weeks old when the photograph was taken, and during this period they were frequently infested with *Aphis rhamni* and *Tetranychus* sp.



Experiments with a number of other plants and aphids indicate that, as a general rule, the protecting effect varies with the weight of the seed Good results were obtained with cotton, pea, various beans and nasturtium, which were successfully protected against attacks by aphids and red spider In some cases a slight stimulating effect on growth has been observed, suggesting utilization of phosphorus by the plant but soaking at higher strength usually inhibited growth This inhibiting effect was observed with most plants when the soaking strength was 2 per cent, but nasturtium seeds can tolerate at least 5 per cent without any ill-effect Small-scale field experiments with peas and beans are at present in progress

This work was carried out while I was working in Great Britain as a research fellow of Imperial Chemical Industries (China), Ltd The hospitality of the Imperial Chemical Industries Laboratories at Hawthorndale and the advice and criticism given by members of the laboratory staff are gratefully acknowledged Thanks are also due to Imperial Chemical Industries, Ltd , for permission to publish this work, a fuller account of which will appear elsewhere

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## Single-Pod Fermentation of Cacao

MANY aspects of cacao research require assessment of quality of the crop produced by experimental trees, and, as it is obviously desirable that such examination should be made as early as possible in the productive life of the tree, only extremely small samples, often the contents of one or two pods at most, are usually available for examination

This communication describes a method for the fermentation of the contents of single cacao pods, which has produced very encouraging preliminary results The method is based on a suggestion of the Cocoa Research Sub-Committee of the Colonial Office

The apparatus consists of a 10-cm Buchner funnel, covered with a half Petri dish with a central hole carrying a thermometer This funnel serves as a fermentation chamber and, in use, its vertical wall is lined with a strip of banana leaf which acts as a heat insulator The stem of the funnel projects through a rubber stopper into a flask which acts as a receiver for the 'sweatings' resulting from fermentation This flask in turn is connected to a controlled air supply, and the flask and funnel are contained in a thermostatically controlled electric oven.

A sample of selected healthy beans from one ripe West African Amelonado cacao pod is prepared for fermentation by mixing it with a 'starter', prepared by adding 2 gm dextrose to 10 c c of pulp from a large batch of cacao which has been allowed to ferment for 24 hr The sample is then transferred to the funnel, covered with two disks of banana leaf and the Petri dish, placed in the oven and the air supply connected

During the period of fermentation, moist air is displaced into the bean mass at a rate of 2 5–3 litres per 24 hr Oven temperatures are adjusted as follows

| | |
|---|---|
| 0–24 hr | 37–38° C |
| 24–72 ,, | 43–44° C |
| 72–86 ,, | 47° C |
| after 86 ,, | 49° C |

At the end of each 24-hr period, the beans are thoroughly mixed by hand to secure uniformity of fermentation Such a procedure does not provide sufficient aeration in the absence of continuous air displacement in the oven When the predetermined period of fermentation is completed, the beans are removed from the funnel, immediately pricked with a pin to prevent shrivelling during drying and dried in the sun for seven days

This method has given consistent results, and 100 per cent of fully fermented beans, estimated on their appearance when cut in longitudinal section, can be produced at will

An independent panel in Great Britain has conducted flavour assessments on beans fermented by this method for four, five and six days and has indicated that samples fermented for five days were the most satisfactory , those fermented for only four days were under-fermented, while those fermented for six days were tainted by a slight flavour of butyric acid

My thanks are due to the Director of the West African Cacao Research Institute for permission to make this communication

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July 19

## Intracerebral Inoculation of Mice : Fate of the Inoculum

IT has long been known that a virus may become widely disseminated following intracerebral inoculation into an experimental animal Thus generalized spread has been found throughout the guinea pig fœtus after intracerebral inoculation of influenza virus[1], vaccinia, tubercle bacilli, and submaxillary gland disease virus[2] , and yellow fever virus has similarly been demonstrated in remote sites after inoculation of the mouse fœtus[3] However, Schlesinger[4] observed that only 3–10 per cent of the inoculum could be demonstrated in the brains of mice one hour after inoculation, whether equine encephalomyelitis virus or bacteriophage was the test agent, and stated that he was unable to account for this loss In view of the common usage of intracerebral inoculation in small animals, it seemed desirable to pursue the matter further

[illegible] *C* 16 bacteriophage, active against a strain of [illegible] *flexneri*, was employed as the tracer substance, and sufficient plaques, in duplicate, were counted to make the results accurate to within at least ± 50 per cent Mice were anæsthetized with ether and chloroform, and inoculated by 25-gauge needle passed to a depth of about 3 mm beneath the skull Between 2 and 8 per cent of the inoculated phage was recoverable with the brain and associated meninges, removed less than 5 min after inoculation (in confirmation of Schlesinger's result) Total recovery of the phage was obtained from a suspension of a whole mouse made in a Waring blendor, indicating that the whole inoculum was still detectable That most of the inoculum had entered the blood-stream seemed likely, as blood taken from the great veins of the neck at various times between 5 and 60 sec after inoculation contained about 15 per cent of the phage per milli-[illegible] In one experiment, about 10 per cent of the inoculum was isolated from the whole head, 2 5 per [illegible] being removed with the brain and 2 5 per cent being present in the subcutaneous tissues at the site [illegible] the injection, at the same time, about 2 per cent [illegible] the inoculum was present in the liver In most experiments the volume inoculated was 0 03 ml, however, volumes as small as 0 005 ml, delivered by a micrometer-screw syringe, were not associated with demonstrably less spill-over into the blood-stream The degree of spill-over was confirmed using a mixture of phage and the *WS* strain of influenza virus, the latter being titrated by allantoic inoculation of 11-day chick embryos, the same fraction of each inoculated virus was found in a sample of blood taken 60 sec after inoculation

How much of the inoculum is in contact with nerve cells is doubtful Much of that which can be removed with the brain is presumably associated with the cerebrospinal fluid and meninges, as was demonstrated by Schaeffer and Muckenfuss[5], who studied the fate of indian ink inoculated intracerebrally into monkeys In summary, intracerebral inoculation of mice deposits only a small fraction of the inoculum into the brain, the remainder being rapidly distributed throughout the mouse via the circulation

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## Nature of the Lung Enzyme which inactivates Serum Vasoconstrictor

RAPPORT *et al* [1] reported the presence of an enzyme, in extracts of beef and dog lung, which inactivates serum vasoconstrictor In an attempt to characterize the nature of the enzyme, we have used their method to make active preparations from sheep lung and have examined them by biochemical, manometric and physiological means

Such preparations are far from pure, they contain oxyhæmoglobin and several active enzymes The addition of hydrogen peroxide shows the presence of large amounts of catalase A red colour on the addition of pyrogallol and hydrogen peroxide, and a dark purple colour on the addition of catechol, dimethylamine hydrochloride and hydrogen peroxide, shows the presence of peroxidase In Warburg manometers at 37° the preparation slowly takes up oxygen at a continuously decreasing rate which is unaffected by the addition of glucose, succinate, pyruvate, lactate, phenol, catechol, tyrosine, tryptophane or glycine The oxygen uptake is increased slightly by lysine and ethanolamine, and very greatly by tryptamine, tyramine or adrenaline, but it is not affected by cadaverine, putrescine and histamine These results indicate the presence of a monoamine oxidase and the absence of a diamine oxidase Acetaldehyde is rapidly oxidized, benzaldehyde slowly oxidized, showing the presence of an aldehyde oxidase

Curve 1 shows the oxygen uptake at *p*H 7 7 and 37° due to 1 5 ml of an active precipitate suspended in an equal amount of *M*/15 phosphate buffer and made up to a final volume of 5 ml with the buffer In the presence of 1 ml *M*/100 tryptamine the uptake (curve 2) is greatly increased for about 1½ hr, after which it runs parallel to curve 1 (see Fig 1) Curve 3 is obtained by subtracting the values of curve 1 from curve 2 The oxygen uptake slightly exceeds two atoms per molecule of tryptamine, suggesting an oxidative deamination of tryptamine with oxidation of the resulting aldehyde and catalytic decomposition of the hydrogen peroxide formed[2] During incubation, control solutions remain light red whereas those containing oxidizable amines become dirty brown and show the spectrum of methæmoglobin

Tryptamine solutions incubated with the lung preparation in Warburg tubes for 2 hr lose about seven-eighths of their activity on the rat uterus or the sheep carotid Histamine solutions show little or no loss of activity on the guinea pig gut, the preparation itself may contain up to 0 1 μgm per ml of histamine Every preparation which destroyed tryptamine also destroyed the activity of sheep serum on the carotid artery After 2 hr the vasoconstrictor activity varied from a quarter to less than an eighth of the original Fig 2 shows the responses of a sheep carotid artery to 0 5 ml of serum (*A*) unincubated, (*B*) incubated with lung preparation for various periods, and (*C*) incubated without lung preparation for 2 hr Over a

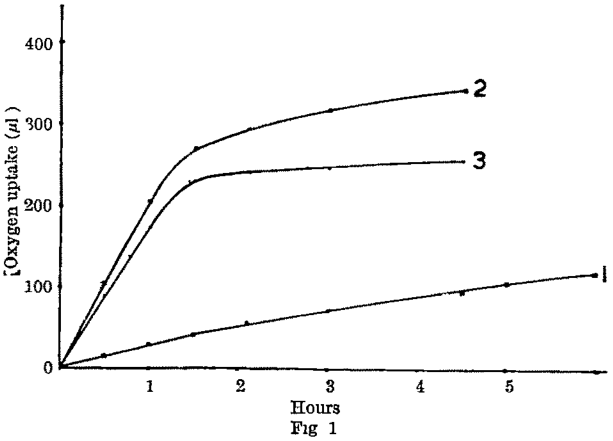

Fig 1

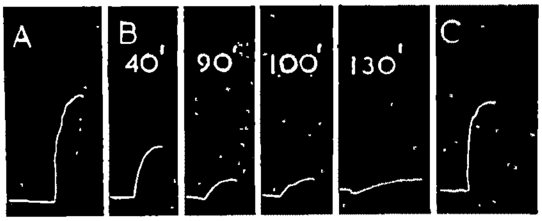

Fig 2

few days the preparations lose their activity against monoamines, and as they do so they also lose their activity against serum vasoconstrictor

These observations suggest that the serum vasoconstrictor contains a free terminal aliphatic aminogroup which is oxidized by a monoamine oxidase in the lung preparation through the same mechanism as that suggested for tryptamine and tyramine

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## A New Method for Preparing Type-Specific Extracts from Hæmolytic Streptococci of Group *A*, Type 2

Hæmolytic streptococci of Lancefield's Group *A* (*Str pyogenes*) can be classified into a number of types on the basis of precipitin reactions with an acid extract of the cocci and appropriate type-specific antisera, the type-specific material in the streptococci is a protein referred to as the *M*-substance[1] It has been a general experience that it is frequently difficult to obtain active extracts from strains of some types, including Type 2 I have found that, if extraction is carried out at neutral *p*H, and at 120° C (in an autoclave) instead of at 100° C, satisfactory extracts are obtained with strains of Type 2

Four extraction methods were compared, using in each case the deposit from 30 ml of an 18-hr culture in broth containing $10^{-5}$ *M* iodo-acetic acid[2] The methods were as follows (1) Extraction at 100° C with 0 3 ml of *N*/5 hydrochloric acid for 10 min followed by centrifuging, neutralization with *N*/5 sodium hydroxide and further centrifuging if necessary, this is the classical method (2) The first method modified only in that the neutralization was carried out immediately after the extraction and before centrifuging (3) The deposit was suspended in 0 5 ml of saline, neutralized with *N*/5 sodium hydroxide using phenol red as indicator, and autoclaved at 120° C for 5 min, it was then centrifuged (4) The same method as in (3) but heating to 100° C for 10 min instead of to 120° C for 5 min In each case the final supernatant was tested for type-specific antigen by the capillary method of Swift *et al*[3] The results are shown in the accompanying table

| Antigen obtained by method | Sera | | |
|---|---|---|---|
| | Group specific | Type-specific | |
| | | Type 2 | Heterologous type |
| 1 | +++ | 0 | 0 |
| 2 | +++ | + | 0 |
| 3 | +++ | +++ | 0 |
| 4 | +++ | + | 0 |

The extract obtained by method (3) was clearly the best, and the fact that the reaction was lost when the extract was digested with trypsin for 24 hr before testing indicates that it was most probably due to the *M* antigen It is also noteworthy that neutralization before centrifuging gave a better extract than the classical method[1], it is probable that the *M* antigen is precipitated at the acid *p*H, and in the case of method (1) is removed in the centrifuging

The experiment described above has been repeat with six other strains of Group *A* streptococci, sidered on the basis of agglutination typing t Type 2, with the same results

Kirsten Rosenda

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Copenhagen

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[1] Lancefield, Rebecca C, *J Exp Med*, **47**, 91 (1928)

[2] Elliott, S D, *J Exp Med*, **81**, 585 (1945)

[3] Swift, H F, Wilson, A T, and Lancefield, Rebecca C *J Exp Med*, **78**, 127 (1943)

## Free and Combined Riboflavin in the Blood Serum of Œstrogenized Fowls

The serum riboflavin of the domestic fowl increases from an average of 0 07 p p m to 0 86 p p m when the bird comes into lay, and remains at this high level while laying increases of the same order can be evoked by the administration of œstrogens to immature pullets[1]

Riboflavin has been shown to exist in the blood serum of rats in three forms as free riboflavin, as flavin mononucleotide and as flavin adenine dinucleotide In investigations into changes in serum riboflavin, it was therefore important to ascertain the relative concentrations of these three forms in both laying and non-laying pullets

At this time, blood from œstrogenized immature pullets became available from other work in progress at this Centre, and this has been examined The birds were Brown Leghorns bred at the Centre, and were ten weeks old at the start of the experiment All birds were fed the same diet, and all received the injections on alternate days They were killed on the day following the last injection, when they were twelve weeks old, and the bloods were examined by the method of Burch *et al*[2] assuming all three forms to be present The treatments and results are set out in the accompanying table

Subsequent dissection indicated that increase in the dose of œstrogen had brought about hypertrophy

| No of bird | Dose of œstrodial benzoate (mgm) | Free riboflavin (p p m) | Flavin mononucleotide (p p m) | Flavin adenine dinucleotide (p p m) |
|---|---|---|---|---|
| *Y* 1314 | 7 × 0 0 | 0 02 | 0 02 | 0 01 |
| *Y* 1306 | 7 × 0 5 | 0 02 | 0 02 | 0 01 |
| *Y* 1311 | 7 × 1 0 | 0 90 | 0 01 | 0 01 |
| *Y* 1356 | 7 × 2 0 | 1 90 | 0 01 | 0 01 |
| *Y* 1320 | 7 × 3 0 | 2 54 | 0 03 | 0 01 |

of the oviduct, and at the higher levels it resembled the fully active organ On the other hand, in all cases the ovaries were quiescent, indicating that endogenous hormone production was negligible

The results show that the increase in serum riboflavin evoked by the administration of œstrogen consisted entirely of free riboflavin, and that the levels of combined riboflavin were not affected They also indicate that changes in serum riboflavin can be followed by estimating the amount of vitamin present in trichloracetic acid filtrates of the serum, thereby greatly simplifying the analytical procedure

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[1] Common, R H, Rutledge, W. A, and Bolton, W, *J Endocrinol* 5, 121 (1947).

[2] Burch H B, Bessey, O. A, and Lowry, O H, *J Biol Chem*, **175**, 457 (1948)

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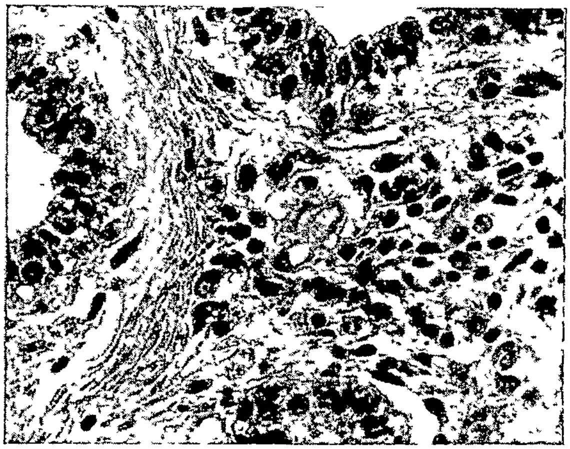
## Plasmacytosis of the Bovine Udder during Colostrum Secretion and Experimental Cessation of Milking

The concomitance of bone marrow plasmacyte formation and induced hypersensitivity was noted by Kolouch[1] in 1938 This was succeeded by a large number of papers indicating the part played by the plasma cell in the secretion of specific antibodies and by clinical studies reporting the strict parallelism between hyperglobulinæmia and plasmacytosis in various diseases These have been reviewed by Kolouch, Good and Campbell[2] The present communication records that the plasmacytosis in the bovine udder is synchronous with heightened periods of immune-body formation at parturition and during experimental cessation of milking

The concentration of immune bodies in the colostrum of cows has been investigated by Smith and Little[3], who showed that transmission of antibody from dam to calf was made through the colostrum rather than by placental transmission as in the n The chemical nature of these proteins has recently been described by E D Smith The great concentration of the immune globulin fraction of the colostrum—many times that of the maternal serum globulin—is noteworthy. Notwithstanding this fact, it has been thought that the source of the immune bodies is in the maternal blood-stream[4] This work has been reviewed by Porter[5] and extended by the demonstration that experimentally the antibody content of milk may be caused to increase to the level of that in colostrum by cessation of milking for a week or more

As the concept of the plasmacytic origin of specific antibodies demands that any such spectacular rise in immune globulin be accompanied by a properly timed wave of plasma cell formation, experiments were set up to make a rigorous test of the hypothesis Three cows were used for the preliminary observations Aseptic serial biopsies of the udder were performed with local anæsthesia in which several grams of secretory tissue were removed These were fixed and sectioned according to usual techniques

Biopsies of No 278 (the cows used were from the herd of the Department of Dairy Husbandry, University of Minnesota), which was neither pregnant nor lactating, showed no plasma cells in the udder Similar biopsies of No 854 showed the abundance of plasma cells eight days prior to parturition These were again found three days before calving, on the day the calf was dropped (see photograph) and four days later A biopsy 18 days after calving revealed no plasma cells In like manner, No *E*607, late in a normal disease-free lactation, was biopsied and a very small number of plasma cells observed to be present Milking was discontinued in two quarters of the udder, and four days later a large population of plasma cells was revealed in the biopsy These were again noted eleven days after milking had ceased Following this third biopsy, the two quarters were again milked regularly, and fifteen days later only a very small number of plasma cells were to be found



Biopsy of mammary gland of cow 854 made on day of calving Note plasma cells in connective tissue septa between alveoli Cresyl Violet and Erythrosin stain

Berry Campbell
Robert M Porter
W E Petersen

Departments of Anatomy and
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July 8

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[1] Kolouch, F, *Proc Soc Exp Biol and Med*, **39**, 147 (1938)

[2] Kolouch, F, Good, R A, and Campbell, B, *J Lab and Clin Med*, **32**, 749 (1947)

[3] Smith, T, and Little, R B, *J Exp Med*, **36**, 453 (1922)

[4] Smith, E L, *J Dairy Sci*, **31**, 127 (1948)

[5] Porter, R M, thesis, Univ of Minn, 1948

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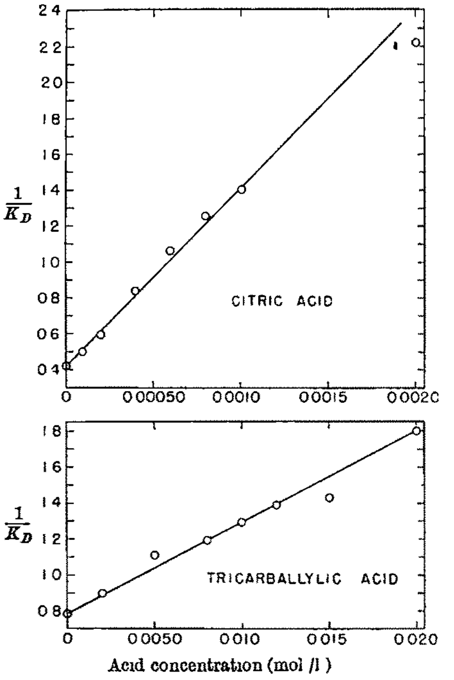
## Complexes of Calcium with Citric Acid and Tricarballylic Acids measured by Ion Exchange

We are engaged in a study of the composition and stability of the complex ions which result from the interaction between metal ions and anions, particularly those of biological importance The determinations are made by measuring the degree to which tracer levels ($\sim 10^{-8}$ *M*) of a radioactive cation are taken up by a synthetic organic cation exchanger in the presence of known concentrations of a complex ion-forming anion[1-3] This ion-exchange procedure has several unique advantages[1] For example, the dissociation constants of several different metal–organic acid complex ions can be measured simultaneously in the same solution, no corrections are



needed for the amount of anion utilized for the formation of the complex ion, and the effect of graded changes in the solutions of such factors as ionic strength, temperature, or dielectric constant can be studied on the same systems Cation exchange resins such as 'Dowex 50'[4] (manufactured by the Dow Chemical Co , Midland, Mich ) are now used in our experiments because their capacity is independent of the $pH$

This communication illustrates the application of the ion-exchange method by presenting the results of measurements made on the interaction of calcium ions with a pair of closely related acids, citric and tricarballylic Citric and tricarballylic acids differ by the presence of a hydroxyl group in the former The experiments are conducted at a $pH$ of 7 2, so that the acids are completely dissociated

The formulæ used for calculation of the dissociation constants are derivable from mass-action considerations[1] In a recent paper on the complex compounds of radium and several organic acids[5], the earlier equations[1] were modified The dissociation constant, $K_c$, of a complex ion $(MA_n)^c$ where $M$ is the cation, $A$ is the anion, $n$ is the number of $A$ groups relative to $M$, and $c$ is the net charge on the complex ion, is

$$K_c = \frac{(A^b)^n}{(K^0{}_d/K_d) - 1}, \qquad (1)$$

in which $b$ is the charge on the anion, $K^0{}_d$ and $K_d$ are the distribution coefficients of the tracer cation between the exchanger and solution phases, in the absence and presence, respectively, of the specific anion The distribution coefficient is defined by the equation

$$K_d = \frac{\%\text{ of tracer in exchanger}}{\%\text{ of tracer in solution}} \times \frac{\text{volume of solution}}{\text{mass of exchanger}} = \frac{\lambda v}{m}, \qquad (2)$$

in which $\lambda$ represents the per cent tracer ratio in equation (2) It is possible to measure $K^0{}_d$ directly or to derive it from values of $K_d$ by graphical [illegible] alytical methods[5] In the former case, values [illegible] $1/K_d$ are plotted against $(A^b)^n$ and the resulting [illegible]igh line (for proper $n$ values) is extrapolated to zero concentration of $A$, as indicated by the relation

$$\frac{1}{K_d} = \frac{(A^b)^n}{K^0{}_d\,K_c} + \frac{1}{K^0{}_d} \qquad (3$$

The tracer, calcium-45, having a specific activity of 1 54 mC /mgm , was added to veronal buffer, which was then mixed with an isotonic saline solution containing a known concentration of the sodium salt of citric or tricarballylic acid The mixtures of the sodium form of the cation exchanger (75 mgm ) and solution (100 ml ) were kept in glass-stoppered Erlenmeyer flasks and shaken mechanically for 2 hr in the case of the systems containing tricarballylic acid and 5½ hr in those containing citric acid In any given series of runs the ratio $K^0{}_d/K_d$ has been found to remain essentially constant even when the absolute values of $K_d$ and $K^0{}_d$ have varied by as much as a factor of three Ordinarily about three hours shaking-time is sufficient to give a satisfactory steady state The β-radiations from calcium-45 were counted through a thin (2–3 mgm /cm ²) end mica-window Geiger tube The cation exchanger was always used in the air-dried form It had a moisture content of 18 25 per cent and contained 4 17 milli-equivalents of sodium per gram

A 1 1 complex with citric and carballylic acid is formed under the conditions studied The extrapolated values of $K^0{}_d$ obtained from the accompanying graph agreed with those measured directly The value obtained for the $pK_c$ of calcium citrate, namely, 3 38 ± 0 04, is in essential agreement with other values recorded in the literature[6-9], particularly when differences in solution composition are considered For calcium tricarballylate, we find $pK_c = 1\ 82 \pm 0\ 03$ At an ionic strength of 0 1279–0 1232, Muus and Lebel[7] using one concentration of tricarballylic acid (0 005 $M$) obtained values of $pK_c$ varying from 1 61 to 1 89

The results show that at physiological $pH$ the presence of the hydroxyl group markedly enhances the ability of citric acid to form complex ions with calcium ions Similar results for the compl[illegible] of strontium and radium have been obtain[illegible]

Some discussion of the factors involved [illegible] formation of metal – organic acid complex ions was given previously[5] It was postulated that the protons in the hydration sheath surrounding the cation tend to form linkages by hydrogen bonding with proton-accepting anions

JACK SCHUBERT
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July 17.

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[1] Schubert, J , *J Phys Coll Chem* , **52**, 340 (1948)

[2] Schubert, J , and Richter, J W , *J Phys Coll Chem* , **52**, 350 (1948)

[3] Schubert, J , and Richter, J W , *J Amer Chem Soc* , **70**, 4259 (1948)

[4] Bauman, W C , and Eichhorn, J , *J Amer Chem Soc* , **69**, 2830 (1947)

[5] Schubert, J , Russell, E R R , and Myers, L S , jun , *J Biol Chem* (in the press)

[6] Hastings, A B , McLean, F C , Eichelberger, L , Hall, J L , and Da Costa, E , *J Biol Chem* , **107**, 351 (1934)

[7] Muus, J , and Lebel, H , *Kgl Dansk Videnskab Selskab Math -fys Medd* , **13**, No 19 (1936)

[8] Cannan, R K , and Kibrick, A , *J Amer Chem Soc* , **60**, 2314 (1938)

[9] Joseph, N R , *J Biol Chem* , **164**, 529 (1946)

# FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

## Monday, November 27

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room, Science Museum, Exhibition Road, London, S W 7), at 5 30 p m —Dr F Sherwood Taylor "The Chemical Studies of John Evelyn", Dr D McKie "John Harris and his Lexicon Technicum"

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 6 p m —Dr W H Glanville "Road Safety and Road Research" (Cantor Lectures) (Further Lectures on December 4 and 11 )

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6 15 p m —Mr E Tunnicliff "The Continuous Vulcanization of Rubber Cables"

## Tuesday, November 28

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (joint meeting with the RADIO SECTION, at Savoy Place, Victoria Embankment, London, W C 2), at 3 30 p m and 5 30 p m —Symposium of Papers on "Radiation Monitoring Apparatus"

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 p m —Dr Julian S Huxley, F R S "New Bottles for New Wine—Ideology and Scientific Knowledge" (Huxley Memorial Lecture)

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 6 p m —Mr Stanley Robson "Chemical Engineering Experiences in the Metallurgical and Chemical Industries" (Seventh Hinchley Memorial Lecture)

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, 16 St Mary's Parsonage, Manchester), at 6 30 p m —Mr C H Bartlett "The Canary Islands"

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 6 30 p m —Dr A R Boyle "The Measurement of Viscosity"

SHEFFIELD METALLURGICAL SOCIETY (at the Grand Hotel, Sheffield), at 7 p m —Mr C E A Shanahan "A Survey of the Physical Chemistry of Sulphur in Basic Steel Making"

TEXTILE INSTITUTE, SCOTTISH SECTION (joint meeting with the EAST OF SCOTLAND SECTION of the INSTITUTION OF BRITISH LAUNDERERS, at the North British Hotel, Edinburgh), at 7 p m —Dr B P Ridge "The New Textiles"

## Wednesday, November 29

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 2 30 p m —Right Hon Lord Horder "Cities without Noise"

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5 15 p m —Mr G E P Box and Mr K B Wilson "On the Experimental Attainment of Optimum Conditions"

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 5 30 p m —Prof H S W Massey, F R S "Post-War Physics" *

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6 30 p m —Mr G Syke "The Beta Ray Thickness Gauge"

## Thursday, November 30

INSTITUTION OF GAS ENGINEERS (joint meeting with the JOINT COMMITTEE ON MATERIALS AND THEIR TESTING, at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 10 a m —Discussion on "Heat Insulation"

ASLIB, NORTHERN BRANCH (in the Civic Hall, Leeds), at 10 30 a m —Conference

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 2 30 p m —Anniversary Meeting

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m —Sir Harold Spencer Jones, F R S "Interstellar Matter" (Further Lectures on December 7 and 14 )

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5 30 p m —Prof M Stacey, F R S "New Ventures in Carbohydrate Chemistry"

## Friday, December 1

CHEMICAL SOCIETY, ST ANDREWS AND DUNDEE SECTION (joint meeting with the ST ANDREWS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Department, United College, St Andrews), at 5 p m —Dr A F Colson "Micro Techniques in Chemistry"

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 6 p m —Dr G Herdan "Statistics of the Sieving Process"

CHEMICAL SOCIETY, MANCHESTER SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Reynolds Hall, College of Technology, Manchester), at 6 30 p m —Mr K Fearnside "The Application of Radioactive Isotopes in Industry"

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Council Room, University College, Gower Street, London, W C 1), at 8 p m —Dr M Sanai "The Relation between Social Attitudes and Traits of Personality"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m —Dr R H Thouless "Thought Transference and related Phenomena"

## Saturday, December 2

BRITISH MYCOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W 1), at 12 noon —Annual General Meeting , at 2 30 p m —Dr G C Ainsworth "A Century of Medical and Veterinary Mycology in Britain" (Presidential Address)

INSTITUTION OF CHEMICAL ENGINEERS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 3 p m —Mr G U Hopton "The Associate Membership Examination"

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Westminster, London, S W 1), at 6 p m —Mr G V E Thompson "The Lunar Base"

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN MINING ENGINEERING, and a TEACHER OF COAL-MINING, in the New South Wales Department of Technical Education—The Agent-General for New South Wales, 56 Strand, London, W C 2 (December 4)

SUPERINTENDENT OF THE MATHEMATICS DIVISION of the National Physical Laboratory in the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3358 (December 7)

RESEARCH ASSISTANT IN THE DEPARTMENT OF CRYPTOGAMIC BOTANY—The Registrar, The University, Manchester 13 (December 8)

SCIENTIFIC OFFICERS (with a good honours degree in physics) at Ministry of Supply Research and Development Establishments mainly in the South of England, for a wide range of research and development in fundamental and applied physics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 310/50A (December 9)

LECTURER or SENIOR LECTURER IN PHARMACOLOGY—The Registrar, The University, Leeds (December 10)

UNIVERSITY DEMONSTRATOR IN PHYSICAL CHEMISTRY—Miss J. Bird, Chemical Laboratory, Cambridge (December 14)

ELECTRONIC PHYSICISTS AND ENGINEERS (Scientific Officer grade) at Ministry of Supply Research and Development Establishments mainly in the South of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 311/50A (December 15)

PHYSICISTS AND ELECTRONIC ENGINEERS (Senior Scientific Officer or Scientific Officer grade) at a Ministry of Supply Research Establishment near London (*a*) ELECTRICAL ENGINEER qualified in radio communications with an interest in the engineering of development prototypes, (*b*) PHYSICIST with interest in the application of electronic techniques to the solution of physical problems, (*c*) PHYSICIST for work on the application of electronic methods to photography of detonation phenomena, (*d*) PHYSICIST (good mathematical knowledge required) for experimental research on the effect of blast—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C.2, quoting A 313/50A (December 15)

LECTURER IN PHYSICAL GEOGRAPHY at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 16)

SENIOR LECTURERS and LECTURERS IN CIVIL ENGINEERING, ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING, in the Department of Technical Education of New South Wales—The Agent-General for New South Wales, 56–57 Strand, London, W C 2 (December 18)

RESEARCH ASSISTANTS (Grade II) IN THE INDUSTRIES DEPARTMENT of the Science Museum and the Science Museum Library—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3373 (December 21)

AGRICULTURAL RESEARCH OFFICERS (3, with honours degree in agriculture of an approved university or an equivalent qualification, and extensive knowledge of tropical or sub-tropical agriculture) in the Department of Research and Specialist Services, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W C 2 (December 23)

CHAIR OF ECONOMICS—The Registrar, University College of Wales, Aberystwyth (December 31)

PROFESSOR OF CHEMISTRY—The Registrar, University College, Cathays Park, Cardiff (December 31)

SENIOR LECTURER IN STATISTICAL METHODS in the Faculty of Agriculture, a SENIOR LECTURER or LECTURER IN ECONOMICS, a SENIOR LECTURER IN AGRICULTURAL CHEMISTRY, and a LECTURER IN BOTANY, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 31)

SENIOR RESEARCH WORKER IN THE DEPARTMENT OF SOCIAL SCIENCE—The Registrar, The University, Liverpool (January 5)

SENIOR SCIENTIFIC OFFICER or PRINCIPAL SCIENTIFIC OFFICER, and a SCIENTIFIC OFFICER, for fundamental biological and physical research with radioactive substances—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth (January 12)

HENRY BELL WORTLEY CHAIR OF METALLURGY—The Registrar, The University, Liverpool (January 13)

Professor of Civil Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 15)

Senior Experimental Officers and Experimental Officers—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3351 (January 31)

Postdoctorate Fellowships for research in pure chemistry and physics—The Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada or the Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W C 2 (Ottawa, February 15)

I C I Research Fellowships in biochemistry, chemistry, engineering, pharmacology or physics—The Secretary, The University, Edinburgh (March 1)

Assistant Physicist in the Radiotherapy Department—The Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton

Assistant Shift Control Managers (with an honours degree in chemistry or chemical engineering, associateship of the R I C, corporate membership of the I C E, or equivalent qualifications) by the Division of Atomic Energy, Sellafield, to be responsible for implementing policy and co-ordinating activities, including nuclear and chemical processes, in a large factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

Demonstrator in Bacteriology—The Registrar, The University, Nottingham

Inspectors of Mines, Nigeria—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27099/13

Instructors (Demonstrators) in Anatomy at the Hadassah Medical School, Hebrew University of Jerusalem—The Friends of the Hebrew University of Jerusalem, 97 Baker Street, London, W 1

Junior Research Officer (male, with honours degree in chemistry, or equivalent) for analytical work, including development and application of analytical methods—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20

Lecturer in the Department of Refrigeration—The Clerk to the Governors, National College for Heating, Ventilating, Refrigeration and Fan Engineering, Borough Polytechnic, Borough Road, London, S E 1

Plant Geneticist to carry out research on the genetics of sisal at the Sisal Research Station, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/171

Research Fellowship in Organic Chemistry—The Chemical Pathologist, Hospital for Sick Children, Great Ormond Street, London, W C 1

Scientific Assistant for work in connexion with the abstracting and indexing of the literature dealing with veterinary science—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture and Fisheries, New Haw, Weybridge, Surrey

Senior Forecaster (with a university degree, preferably in science, and specialized in meteorology) by the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M N 26337/3E

Senior Physicist at the Hogarth Radiotherapeutic Centre—The Secretary, Nottingham No 1 Hospital Management Committee, General Hospital, Nottingham

Technical Records Assistant Manager (with an honours degree in chemistry, associateship of the R I C, or equivalent qualifications) by the Division of Atomic Energy, Capenhurst, to be responsible to the Technical Group Manager for the organization and operation of the technical records and statistical department of a large chemical engineering factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

University Graduate in Science, preferably with postgraduate training and 2–5 years experience in hydrodynamics or aerodynamics, and ability to apply theoretical principles to research and development problems—The Defence Research Board, Department of National Defence, Cartier Square, Ottawa, Ont, Canada, or Defence Research Member, Canadian Joint Staff, 11 Hill Street, London, W 1

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# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Medical Research Council Special Report Series No 270 Reports on Biological Standards, 6, The Design of Toxicity Tests By W L M Perry Pp vi+51 (London H M Stationery Office, 1950) 1*s* 6*d* net [178

Superannuation Scheme for those engaged in the National Health Service an Explanation Revised edition Pp ii+26 (London H M Stationery Office, 1950) 3*d* net [178

Northern Advisory Council for Further Education Third Annual Report 1949–50 Pp 39 (Newcastle-upon-Tyne Northern Advisory Council for Further Education, 1950) [218

Rothamsted Experimental Station Report for 1949 Pp 178 (Harpenden Rothamsted Experimental Station, 1950) [218

British Standard 351 1950, Friction Surface Rubber Transmission Belting Pp 12 (London British Standards Institution, 1950) 2*s* net [218

British Standard 340 1950, Pre-Cast Concrete Kerbs, Channels, Edgings and Quadrants Pp 16 (London British Standards Institution, 1950) 2*s* 6*d* net [228

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# THE RUTHERFORD MEMORIAL

IN his anniversary address to the Royal Society, Sir Robert Robinson referred to the launching by the Society of an appeal for a Rutherford Memorial Fund (see p 929 of this issue of *Nature*) A special committee, consisting of Sir Henry Tizard (chairman), Prof E N da C Andrade, Sir James Chadwick, Sir Charles Darwin, Prof A. V Hill and Prof M L E Oliphant, set up by the Council of the Society, has been considering the most suitable memorial, and it is thought that it should take two forms (1) Rutherford Scholarships tenable for three years, to be awarded to postgraduate students within the British Commonwealth, for research in the natural sciences, with a preference for experimental physics A scholar will normally be required to carry out his research in an institution in some part of the British Commonwealth other than that in which he graduated (2) A Rutherford Memorial Lecture, to be delivered at intervals at selected university centres in the British Commonwealth overseas, at least one in three to be given in New Zealand

It is proposed also to arrange for the collection, arrangement and binding of copies of Rutherford's correspondence, and its preservation in safe custody for future reference

An appeal for a memorial to Lord Rutherford requires no commendation from us, we believe, however, that readers of *Nature* will appreciate the impressive but brief record of Lord Rutherford's life and the significance of his work for the progress of science, prepared by Prof P I. Dee, which is printed below

THE discovery of X-rays by Rontgen in 1895 is often cited as the starting point of a new scientific era An event of equal significance to science in that same year was the arrival in Cambridge from New Zealand of Ernest Rutherford, then aged twenty-four, just in time to be registered as the first research student at the Cavendish Laboratory under a new statute which allowed graduates of other universities to become eligible for a higher degree after two years work at research Within a year, Rutherford, following up work which he had done in New Zealand, developed a magnetic detector which made it possible to receive wireless signals over a distance of half a mile It is fortunate, however, for science that, during the following two years, discoveries were made in other fields which deflected the interests of Rutherford from the developments of wireless communication to a subject of infinitely greater generality and importance

In order to form a background for the assessment of Rutherford's work and also to appreciate the effect of these discoveries upon the mind of the young researcher, it is necessary to consider the state of science in these concluding years of the nineteenth century The great developments of the atomic theory, stimulated by the growth of chemical industry, seemed to provide a final scientific description of the laws of chemistry and of the nature of matter The brilliant success of the application of the Newtonian scheme in the kinetic theory of gases was a further triumph for atomism and apparently justified the expectation that all the physical phenomena relating to matter, like those of chemistry, merely awaited a routine application of the same principles Fundamental in this outlook was the belief that the material atoms were eternal and indestructible The work of Joule upon the quantitative equivalence of heat and energy had similarly established the constancy of available energy The wave theory of light extended by the work of Faraday and Maxwell had marked the beginning of field physics, and although the situation here was less clear, only few could have doubted that a complete unification of physical science would accrue from the application of the Newtonian concepts to atoms and to some form of luminiferous ether

Within thirty years, most of these tenets had been abandoned The facts of radioactivity had not only established the impermanence of atoms, but also had been brought within one comprehensive scheme which showed in detail the nature of the transformations which such atoms undergo Atoms, previously definable in terms only of mass, had been shown to have a complex structure in terms of which their properties received a comprehensive description The possibility of effecting atomic transmutations under human control had been experimentally established, the vast store of energy available within the atomic nucleus revealed, and the foundations laid for its exploitation Rutherford himself was not only responsible for the brilliant conception of the key experiments which established each of these discoveries, but was also directly responsible for their execution

A similar revolution in outlook has also occurred during the present century in regard to field physics, namely, in the development of quantum and wave mechanics and of the theory of relativity The replacement of Newtonian mechanics by quantum mechanics followed directly upon the successful attempt by Bohr to account for the emission of light by atoms by applying Planck's quantum of action to the Rutherford planetary atomic model Einstein's theory of relativity receives its most convincing experimental verification in the quantitative equivalence of matter and energy as revealed by experiments upon artificial transmutation of matter Rutherford's work, therefore, may be regarded as catalytic over the whole great range of modern physics, but his supreme contribution lies undoubtedly in his brilliant exposition of the most ultimate structure of matter

Having thus sketched the broad outlines of Rutherford's contribution to modern physics, it is interesting to review in slightly more detail the dominant phases of his work, since this will make it possible to give a few chosen examples which illustrate his great genius as an experimenter and his wholly exceptional scientific insight

Rutherford's work falls into three main phases the first at Montreal, the second at Manchester and the third at Cambridge In 1898, after only three years research as a student at Cambridge, Rutherford was appointed professor of physics at Montreal at the early age of twenty-seven In a letter to his mother he said, "I know you will be pleased to hear that I have got the Montreal post and so start up in life as a Professor with £500 a year and an unlimited prospect of work" It is easy now to envisage this unlimited prospect of work During his previous two years at Cambridge, Rutherford had worked under the direction of J J Thomson on the celebrated investigations relating to the conduction of electricity through gases, which later resulted in Thomson's discovery of the electron Shortly after Becquerel's discovery of the blackening of photographic plates by salts of uranium, it was shown that these salts had also the property of making gases conductors of electricity Rutherford had already investigated some of the properties of these supposed radiations from uranium and thorium compounds The problem was one of incredible difficulty and complexity A large number of distinct, and, at that time, unrecognized phenomena were involved in the experiments Thus, two types of radiation, the α- and β-rays, were emitted from these substances The rate of emission of the radiation from each substance decayed according to an exponential law The process of radioactive decay gave rise to new substances which were also radioactive and which decayed at different rates, in some cases these product sub-stances were gases which, under the influen draughts, gave rise to wildly inconsistent r Futhermore, the radioactive decay of these g emanations formed radioactive deposits upo of the apparatus, giving thereby the possibi further inconsistencies One saving feature of the phenomena was the fact that in some cases bodies with different radioactive properties possessed different chemical behaviour By a series of investigations, brilliant both in conception and execution, Rutherford and Soddy, within three years, laid down the basic principles underlying these phenomena and put forward, with incontrovertible evidence, their theory of "radioactive change Radioactive change, therefore, must be of such a kind as to involve one system only the changing system must be the chemical atom in radioactive change the chemical atom must suffer disintegration"

This great work, which not only destroyed the concept of the permanence of atoms, but also made clear the laws according to which certain atoms are transformed spontaneously from one species to another, formed the dominant theme of Rutherford's work during the Montreal period By 1904, the general principles had been applied with great skill to the successive decay products of the radium family. The nature of the genealogical tree for a connected series of radioactive decay products was put forward in a form which has not since required substa modification It is difficult even nowadays to ima how such a complex range of phenomena could h been separated and systematized in so short a ti Rutherford was destined later to obtain results of even greater importance and generality, but it is probable that this phase of his work represents the most brilliant piece of imaginative experimentation ever performed in the history of physical science

After nine years at Montreal, Rutherford accepted the Langworthy chair of physics in the University of Manchester Here, in collaboration with Geiger, then a young assistant, techniques were developed for the detection of individual atomic particles This was to have a far-reaching effect upon future work In experiments using these techniques upon the scattering of the α-particles from radioactive substances by very thin metallic foils, it was observed that on very rare occasions some of the α-particles were scattered through large angles Rutherford's grasp of the fundamentals of his subject, combined with his great imaginative insight, stimulated him to pursue this trivial clue which so many would have neglected He found it possible to reconcile the observations only with a concept of the atom as possessing a massive minute nucleus The law of scattering which followed mathematically from this assumption was worked out, and, within a few months, accurate new experimental results were available which confirmed the hypothesis in minute detail The planetary model of the atom was in this way first established The subsequent application of quantum mechanical principles by Bohr to the Rutherford atom model gave a comprehensive description of the optical spectra of the elements Moseley's brilliant investigations on the X-ray spectra of the elements gave the concept of atomic number and system-[illegible] the applicability of Rutherford's atom model [illegible] whole range of natural elements [illegible]range once said that Newton was not only the [illegible]atest genius who ever lived, but also the most [illegible]unate, "for there is but one universe, and it can [illegible]ppen to but one man in the world's history, to be the interpreter of its laws" Rutherford's achievement in revealing the character of the infinitely small atomic world, and the far-reaching consequences of this and his other work upon all fields of physical science, must surely give him place with Newton as the greatest physicists of all time

Despite serious interruption of his scientific work by the First World War, Rutherford had, by 1919, published the results of yet another epoch-making discovery Following upon his discovery of the atomic nucleus, Rutherford made experiments to probe the nature of this minute nucleus by bombarding matter with the α-rays from radioactive substances In such experiments he showed conclusively that when nitrogen was bombarded with α-rays there occurred a rare but definite emission of fast hydrogen nuclei. This was the first occasion upon which controlled transmutation of matter was successfully accomplished Shortly after this discovery, Rutherford succeeded Sir J J Thomson as Cavendish professor of experimental physics at Cambridge, and it was in the Cavendish Laboratory that the main part of this third great phase of his work was carried out In collaboration with Chadwick, the earlier experiments were repeated and extended to many other elements Convincing proof was given that atomic transmutation could, in fact, be effected by these means During the subsequent decade a multitude of other experiments, which, by normal standards, would rank as highly important, were carried out by Rutherford and his collaborators

The final climax of this work came, however, in the year 1932, following a period of intense progress in techniques. In that year, Chadwick, working at the Cavendish Laboratory, discovered the neutron, and Cockcroft and Walton succeeded in disintegrating the lithium atom by artificially accelerated protons These two great achievements carried out in Rutherford's laboratory owed much to his direction and encouragement In his Bakerian Lecture before the Royal Society in 1920 Rutherford had postulated the existence of a neutron and successfully given an uncannily correct prediction of its properties In this same Lecture he concluded, "The existence of such atoms [neutrons] seems almost necessary to explain the building up of the nuclei of heavy atoms" Thus, with typical insight, he foreshadowed the present nuclear model in which neutrons and protons constitute the elementary structural units The experiment which effected the entirely artificial disintegration of lithium by Cockcroft and Walton was carried out at Rutherford's direct instigation The dream of the alchemists had at last been realized, and although, of course, there were many co-workers in the final stages of this work, it is clear that Rutherford was the outstanding genius responsible for the basic conceptions and also for personally conducting by far the greater part of the experimental work

Rutherford died in 1937, and therefore did not live to see the great technological developments which have extended this work to macroscopic quantities of matter and made possible the utilization of the vast store of nuclear energy for the benefit of man If, as we all hope, these possibilities are not frustrated by political error, Rutherford's part in bringing the forces of Nature to the useful service of man will surely rank supreme

During Rutherford's lifetime the problem of atomic structure was completely solved, and the outstanding problem in regard to the constitution of matter now lies in the study of the structure of the nucleus revealed by his experiments Despite the great amount of work which has been done, this latter problem so far seems to lack entirely the elegant simplicity which the genius of Rutherford made sufficient for the description of the atom This may, of course, be a fundamental consequence, but those who knew Rutherford well have added cause to regret the absence of his leadership in these momentous years

At a recent conference on nuclear physics, held at Oxford, Niels Bohr, in the concluding address, said "This gathering would not be complete without remembering the one who was so loved and respected by each one of us who knew him, the one who not only discovered the nucleus of the atom, but who revealed the transformations which it can undergo, and finally guided the researches which made it possible to effect these transformations under controlled conditions Out of his work has grown the whole of this great subject of nuclear physics with its far-reaching potentialities" To a gathering of physicists drawn from all parts of the world, Bohr did not find it necessary even to mention the name of this one man

P I Dee

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# HUSSERLIANA

## Cartesianische Meditationen und Pariser Vortrage

Von Edmund Husserl Herausgegeben und eingeleitet von Prof Dr S. Strasser (Husserliana, Band 1) Pp xxxi+244 10 guilders.

## Die Idee der Phanomenologie

Funf Vorlesungen Von Edmund Husserl. Herausgegeben und eingeleitet von Walter Biemel (Husserliana, Band 2) Pp xi+94 3 90 guilders (The Hague Martinus Nijhoff, 1950)

TO attempt a review of the work of an outstanding figure of a marked philosophical period is a responsible task at any time If his thought is difficult, and in part even obscure, the emphasis should perhaps be upon elucidation and, to a limited extent, upon re-statement For such a one as Edmund Husserl, however, little of this traditional simplification is feasible he was a sublime artist in the realm of pure thought. Nobody could expect him to be other than completely individualistic and what is occasionally—and not unaffectionately—called 'impossible'

But what matters now, some twelve years after his death, is to realize that he left some forty thousand pages of manuscript unedited, and in a shorthand of his own The whole learned world can do little more than stand amazed at the faith, hope and charity of the University of Louvain, and associated academic bodies, in establishing a special foundation (Husserl-Archiv) to deal with these unique papers, and now to issue them, after long years of toil, for the benefit of students and scholars of phenomenology When the perils of some five years of enemy occupation are added to the story, the magnitude of this labour of love can in some measure be assessed On a brief visit to Louvain in 1948, I was enabled to see the work in progress, and to hear about it at first hand No privilege could have been greater

Of the two stately volumes now published, the first, edited by Prof S Strasser, of Nijmegen, contains essentially the four lectures which Husserl gave at the Sorbonne in February 1929 This set may be considered as the precursor of his more widely known "Cartesian Meditations" A survey of the course, by the master's own hand, follows Prof R Ingarden, of Cracow, was in touch with Husserl concerning these lectures, and a selection of his notes is added The "Meditations" derive their importance from the fact that they contain the basic *Systematik* for a transcendental phenomenology, and a first pointer to the place of metaphysics in the new science To the author, they were vital or, as he says, "the chief work of my life" Husserl is here largely concerned with the influence of empathy, or the way in which the experience of other minds may impinge upon our own For him there is no alternative path to the constitutive phenomenology which he seeks in all its fullness It is significant that, in this connexion, the loss of the world must be faced This happens by reason of the necessity for "reduction" (to be explained later), though afterwards it may be possible to recapture it in an all-pervading self-consciousness

In passages of this kind, it is clear to what depths of insight Husserl had penetrated "That which thou sowest is not quickened except it die", applied originally to all human endeavour, means for him the "tabernacling of truth" in the self It is but an example (there are several others), patent or latent, in the author's writings as a whole, of the way in which phenomenology increases the resolving power of the mind The analogy in optics would be that, beyond the limit at which useful magnification has been reached, further information is only obtainable by decreasing the critical separation, and providing brightness enough to stimulate photopic (and incidentally chromatic) vision In an epistemological process somewhat akin, we are saved from the agnostic state of being forced to admit that objective truth is for ever beyond us Perhaps it should be mentioned at this point that by no means all those who have at one time or another sat at the feet of Husserl accept his later transcendental idealism inherent in the "Cartesian Meditations" Something of a revolt can even be discerned earlier in connexion with "Die Idee", to be discussed later Meanwhile, the whole psychological state and development of the philosopher's own mind must be appreciated before any judgment is permissible in the case of one wholly possessed by the ideal of a presuppositionless structure

Volume 2, "Die Idee der Phänomenologie", is the devoted work of Dr Walter Biemel in editing and arranging the text It comprises essentially the five lectures which Husserl delivered at Gottingen in the spring of 1907 They reveal clearly that the master was intent at that time upon the core of his idealism, six years earlier in fact than some commentators would allow But to grasp the meaning of this course, it is necessary to understand something of what had previously happened, something indeed so potent as to shake the philosopher's entire being This was no less than the humiliation of being rejected for the professorship at Gottingen, after having received the recommendation of the Ministry of Education for the chair That such a setback should come some six years after the appearance of the first edition of the "Logical Investigations" generated in Husserl's mind such cold blasts of doubt as to force him to ask himself the question wherein lay his title to that c[illegible] philosopher Nevertheless, out of evil came good [illegible] turning-point had been reached, and the world[illegible] scholarship was to be enriched by a forging of a tool, if not entirely new at least more accurately tempered for its task than any device previously fashioned This was no less than Husserl's famous ἐποχή, or rather his particular version of it To understand it is to inject a pseudo-metaphysical meaning into the common English equivalent 'epoch' Originally taken to refer to the transit of a star, it became associated with the concept of suspense, or the state of affairs at the highest point, just before the beginning of decline Perhaps the almost perfect verbal image is to 'hover', and this is exactly what Husserl intended to do in his suspension of judgment of transcendentals, which has also been called 'bracketing' As I have pointed out on a previous occasion, this process of incomplete elimination does not necessarily preclude the act of enmeshing again, once the need for waiving has become less coercive In other words, entities so treated are not automatically assumed to have passed for ever beyond recall Husserl uses this machinery in place of the universal doubt of Descartes Broadly, the phenomenological ἐποχή is a more robust method of handling judgments—which are not for us to assess—than the roughly similar artifice used by the School of Sceptics in the third and fourth centuries B C

The problem of how objects are constituted, and the connexion with consciousness, is the kernel of these lectures The method of phenomenological reduction is itself the approach to transcendental means of contemplation In the end, this technique convinced Husserl that it was the foundation of all science and epistemology Dr Biemel makes a brief mention of the lecture on "thing-hood", a veritable *tour de force* which Husserl's pupils failed to understand, at any rate at the time The difficulties proved too great

Phenomenology is more than an academic study for those who embrace it and follow faithfully wherever it leads, it offers a life to be lived, and a goal for which to strive Yet the Husserl-Archiv is in no way committed to it in principle or in practice, as Dr H L van Breda in his preface is at pains to make clear It is solely to the abounding disinterestedness of that foundation, and the distinguished work of its publishers, that we owe this gift to scholarship, and maybe—in however slight a degree—to the healing of the nations

In August 1914, the late Lord Grey of Fallodon made his memorable remark to the effect that the lights of civilization all over Europe were going out In very truth, they have never been rekindled much beyond a fitful flicker ever since. But however that may be, from Louvain has now come this bright beam, illuminating, as it were, the clouds of to-day, and scanning them as with a searchlight

F I G RAWLINS

# EXCHANGE AND CEREMONY AMONG AUSTRALIAN ABORIGINES

## Economic Structure and the Ceremonial Exchange Cycle in Arnhem Land

By Dr Donald F Thomson Pp vi+106+11 plates (Melbourne and London Macmillan and Co , Ltd , 1949 ) 12*s* 6*d* net

IT has been known for a long time that the social life of the Australian aborigines is not as simple as their primitive technology might suggest But it is only gradually that even anthropologists have realized how complex and how important to them are their ceremonial exchange cycles Articles in great variety, such as spears, boomerangs and shields, red ochre and other pigments, pearl-shell ornaments, pounding and grinding stones, beeswax, even narcotics from species of *Duboisia* and *Nicotiana*, are passed from hand to hand and travel immense distances, sometimes hundreds of miles from the place where they were produced This exchange fulfils very important economic functions But it has wider interest, too The process is rarely one of barter, it is one of gift and counter-gift, with elaborate ceremonial Repayment is often not immediate, but delayed, in a credit system which has ritual as well as economic sanctions There is obligation not merely to repay, but also to give, to maintain the social ties and to keep up the status of the giver The exchange is not random, with anyone who is willing, but takes place as a rule between regular partners in different groups, who may keep this relationship for life Such long-period linkage is helped by the fact that kinship provides a common basis for partnership The exchange therefore expresses and reinforces kinship ties and is part of a general social fabric

Dr D F Thomson has made here a valuable contribution to this whole study He knows Arnhem Land very well, from several expeditions, and has given an authoritative account of the way in which the aborigines there use their resources with care and skill, and augment them by ceremonial exchange of an intricate kind In some craft usages, such as a specialized type of fish trapping, the people follow patterns believed to have been laid down by the totemic ancestors of a group, and restrict the distribution of the process or the article from a pious belief in the importance of group solidarity Yet many other kinds of goods are in constant circulation, such as flint spear-heads, human-hair belts, opossum-fur aprons, fighting clubs, and calico and various kinds of iron goods Many of these types of specialized artefacts must have been used for centuries in a traditional exchange system But it is part of Dr Thomson's thesis that a new impetus was given to the exchange cycle by contact of the Arnhem Land aborigines with visitors from Macassar and neighbouring Indonesian areas, who brought cloth, iron tools, tobacco, bottle glass and other foreign articles during a period of about two hundred years The whole exchange takes place along fairly definite trade routes From the point of view of any one participant, each type of object must be handed on in the direction opposite to the one from which it was acquired Each person acts as a clearing house for a short time, then passes the goods on to his partners in the appropriate direction The result is a complex system of movement and counter-movement of objects, making an enormous network of relationships between people The canalization of the exchange flow has its own terminology, reference being made to direction somewhat after the style of 'quarters' of the compass The result is fascinating reading, with the various ceremonial threads skilfully disentangled

Good as much of the analysis is, it omits discussion of important problems No information is given about exchange-rates, yet this might have helped to elucidate the rather nebulous account of the relation between economic and ceremonial factors A canoe-maker is paid in bundles of spears, baskets and tomahawks, by gift, and liberally But we are not given any idea of the value of these things relative to other objects in the system There are no data about velocity of circulation—it would have been relevant to understanding the relative demand situation to know how long it takes representative objects of different types to travel across the region To estimate the volume of exchange would not have been easy But some data could doubtless have been given about the kinds and amounts of goods passing, say, between two partners in the course of a year, or inwards to and outwards from a camp It is mentioned that one man who was a consistent informant of Dr Thomson's was a very active participant in exchange This suggests that there were others less active Since the obligation to exchange is represented as being so strongly sanctioned, an analysis of the reasons for more or less participation would have been useful The prestige gained from acting as a middleman, especially in handling goods of the type obtained from the Indonesians, is noted But no consideration is given to the question of any middleman's profit This would strike any economist as a most likely incentive to exchange, especially since Stanner[1] has pointed out, for another region to the south-west, that there is a practice of 'milking' some objects, such as lumps of red ochre or beeswax, when they pass through one's hands As a final point, while it is true, as stated in the book, that no definitive account has yet been published of the economic exchange of the Australian aborigines, mention might have been made of McCarthy's useful synopsis[2]

The book is thus not as helpful as it might have been on the quantitative side, and to this extent has its limitations for the theory of primitive exchange But it gives a vivid picture, in a not too technical form, of the workaday life of these aborigines, and the way in which this is integrated with their kinship system and their ritual system Good photographs illustrate major crafts, and two maps show the workings of the ceremonial exchange system

RAYMOND FIRTH

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[1] Stanner W E H , "Ceremonial Economics of the Mulluk Mulluk and Madngella Tribes of the Daly River, North Australia A Preliminary Paper", *Oceania*, **4**, 156 and 458 (1933–34)

[2] McCarthy, F D , "'Trade' in Aboriginal Australia, and 'Trade' Relationships with Torres Strait, New Guinea and Malaya", *Oceania*, **9**, 405 (1938–39), **10**, 80 and 171 (1939–40)

# MODERN COLLOIDS

## Frontiers in Colloid Chemistry

Edited by R E Burk and Oliver Grummitt (Frontiers in Chemistry, Vol 8 · Published under the auspices of Western Reserve University ) Pp x+157 (New York and London Interscience Publishers, Inc , 1950 ) 32*s*

THIS volume, the eighth, will be the last of this well-known series to appear, due to "the fact that it has become increasingly difficult to obtain outstanding speakers on the condition that it is necessary to write a chapter in a form suitable for publication" Many will hear of this decision with regret, for there is no doubt about the success of the earlier volumes of "Frontiers in Chemistry" in their avowed object of assisting chemists to keep abreast of modern developments Unfortunately, the present volume is handicapped by an unduly long time-interval between publication and the giving of the lectures The paramount importance of rapid publication is underlined by the footnote to Prof H S Taylor's article "Since the lecture was given [February 23, 1945] rapid developments in the science of adsorption phenomena have made necessary a complete revision of the material previously presented What is here published in book form may be regarded as representative of what the writer might have said if the lecture had been delivered in October, 1948 " Not all the other lecturers have attempted such a drastic revision, thus further emphasizing the lack of uniformity in presentation which is inevitable in any composite volume

The six topics covered, given by physical chemists too well known to need introduction, are as follows "The Role of Adsorption in Colloid Science", by H S Taylor, "Frontiers in Chromatographic Adsorption Analysis", by H H Strain, "Ion Exchange with special reference to Synthetic Resins", by R J Myers, "Sedimentation", by V R Damerell, "Colloidal Electrolytes, Wetting Agents and Detergents" and "Organisation of Crystals and Micelles of Soap, Solubilisation and Detergency", both by J W McBain

Prof Taylor deals with adsorption on solids with special reference to the forces operative between solid surfaces and gases This article is one of the best in the series, the subject is developed in a logical and interesting form, and the references give a balanced picture of the major contributions to the topics under discussion

The survey of chromatographic adsorption analysis presented by Dr Strain covers a very wide field, with a consequent sacrifice of depth of treatment A reader new to the subject will undoubtedly find this a very valuable introduction , but with the present widespread use of chromatography there must be many who would have preferred a detailed discussion on a more restricted basis

The subject of ion exchange has developed considerably in recent years with the introduction of the synthetic resin-type of exchanger Dr Myers gives a general review of recent work, the treatment evidently presupposing little previous knowledge of the field The reviewer would disagree with the writer on certain points, such as the statement (p 67, Chart 4) that the adsorption layer consists of "a thick layer on surface of solid [sedimentation volumes]"

Dr Damerell reviews recent investigations on the phenomena associated with sedimentation under gravity or centrifugal forces Certain parts could probably have been omitted with advantage , for example, the account of the ultracentrifuge optical systems would, in the absence of any diagrams, mean little to someone unfamiliar with the subject Apart from this criticism, the field is well covered both in the text and from the point of view of references

The concluding two articles by Prof McBain reflect the delay in publication to a striking degree Recent advances in the general realm of soaps and detergents have outmoded so much of their contents that a reader unfamiliar with the field will acquire many false impressions

Most chemists will find some sections of this book of interest and of value, but few will find it of sufficient worth to warrant purchase for their private libraries

# THE STRUCTURE OF SOCIETY

## Social Structure

By Prof George Peter Murdock Pp xix+387 (New York The Macmillan Company , London Macmillan and Co , Ltd , 1949 ) 33*s* 6*d* net

THE social sciences are often criticized on the ground that, so far as the form and content of social relationships goes, they are intuitional rather than objective in their methods, that their conclusions are limited in significance to the conditions of a given time and place, and they are fundamentally lacking in generality It is in order to give them a basis of hard fact that the Cross-Cultural Survey of the Yale Institute of Human Relations was created, and Prof G P Murdock's work affords a most interesting example of the uses to which the elaborate information included in the Survey concerning some hundred and fifty human societies can be put

The present work is an attempt to show how the various parts of a total of two hundred and fifty societies interlock functionally, and to demonstrate that certain characteristics can be made the basis of useful classification Statistical methods have, for example, been used to unravel the mysteries of kinship terminology, and the conclusion has followed that the permutations and combinations of the elements of social organization "conform to natural laws of their own, with an exactitude scarcely less striking than that which characterizes the permutations and combinations of atoms in chemistry or genes in biology" This has led to the formulation of a number of postulates and theorems which will arouse much discussion among anthropologists

Prof Murdock is, however, no mere classifier, content to leave the formulation and criticism of hypotheses to others Although more attention is paid in his book to the analysis of the formal structure of the societies with which he deals, he enters the field of interpretation at many points In the section devoted to incest taboos, for example, he examines the criticisms which have been made against Freud's treatment of the subject and builds on this a penetrating study of the possibility of constructing an adequate explanation of the function of taboos associated with remoter relatives The intellectual tools of four separate systems of social science theory —psycho-analysis, sociology, psychology and cultural anthropology—are thus brought into simultaneous use A most attractive field for collaboration is opened up in this way

T SIMEY

## The Social Sciences

A Problem Approach By Prof Paul A F Walter, Jr Pp vii+357 (New York D Van Nostrand Co, Inc, London Macmillan and Co, Ltd, 1949) 20s net

ONE of the chief problems which arises in teaching the social sciences is that they all deal with separate aspects of the same subject-matter, namely, the behaviour of man in society What is now termed 'the multi-disciplined approach' in the United States has brought several of these sciences into co-operative relationship at the higher level of postgraduate study and research, particularly so far as sociology, social psychology, psychiatry and social anthropology are concerned The undergraduate student of any single social science, however, is still left either in the squalid isolation of a single and very incomplete science, or floundering in any attempt he and his teachers may make to discover the boundaries between his own specialism and those of others, or to determine the extent to which the findings of each throw light on the problems of all

Prof P A F Walter has courageously tackled the task of outlining the contributions which anthropology, economics, history, political science, social psychology and sociology have made to the study of the ways in which social problems come into being and have assumed an ever-growing measure of importance in the life of the ordinary man Using what he calls the "Problem Approach" as the centre of gravity of his work, he has been able to provide a stimulating discussion of the points of view of each of the social sciences, and it is particularly suited to the needs of the elementary student

A further merit of the book lies in the fact that it is intended to interest the student in principles and methods rather than to serve as a compendium of information, like so many other elementary textbooks The assumption is that the teacher should supplement it with a body of material applicable to problems of direct interest to his students If this is done, an excellent first-year course could be given which would reduce substantially the intellectual hoydenism which is deplorably common among students of the social sciences T S

## Multiple-Beam Interferometry of Surfaces and Films

By Prof S Tolansky (Monographs on the Physics and Chemistry of Materials) Pp viii+188 (Oxford Clarendon Press, London Oxford University Press, 1948) 18s net

AS the first of a new series of monographs, summarizing the recent results of academic or long-range research on the physics and chemistry of materials, this volume describes the optical interference techniques developed since 1942 by Prof S Tolansky

The first four chapters explain the production of very sharp monochromatic Fizeau fringes between highly reflecting silver films of low absorption, spaced only a few wave-lengths apart, illuminated normally by parallel light These fringes, when produced between an optical flat and a silvered crystal surface, give contour lines which enable differences in surface-level to be measured to 5 A or better Crossed Fizeau fringes, photographed by double exposure for two slightly different inclinations between the surfaces, and fringes of equal chromatic order obtained with white light and a spectroscope, are powerful extensions of the basic technique Prof Tolansky describes the application of these methods to the surface topography of crystals, and also deals with a number of other interesting results such as Donaldson's colour filters, the demonstration of phase-change on reflexion at a metal surface, and the effect of birefringence in mica films

While the book is primarily intended for the research physicist, it gives an excellent account of the general theory of thin-film interference which should be valuable to students The half-tone reproductions of interferograms are very good G R NOAKES

## Advanced Chemical Calculations

By Sylvanus J Smith Pp viii+454 (London Macmillan and Co, Ltd, 1950) 17s net

BY "advanced" the author means "beyond the matriculation stage" Accordingly, fifteen of the twenty-one chapters deal with calculations concerning atomic weights, the partition law, mass action, electrochemistry, volumetric analysis, problems in organic chemistry and such other subjects required for university scholarship, intermediate science and similar examinations Except for a few in Chapters 5 and 7, all problems in this section (Chapters 1–16) are meant to be solved without the use of the calculus In Chapter 7 the author introduces partial differentiation, and later on makes frequent use of it, especially in Chapters 17–21, which deal with maximum work, the second law of thermodynamics, the Gibbs–Helmholtz equation, concentration cells, standard electric potential and Nernst's heat theorem The problems treated in these last six chapters are of the type set in honours degree papers Mr Smith begins each chapter with not one, but several examples, worked out step by step, with brief running explanations which betoken the experienced teacher To say that in the whole book there are 193 of these illustrative examples is to give some idea of the labour given to its making Each chapter ends with an abundance of varied problems for solution In addition, there are two long sets of miscellaneous numerical questions An appendix contains a brief discussion of the significance of partial differentiation, several tables including one of logarithms, answers to all the numerical questions and an index Mr Smith has done a good piece of work and has produced a book valuable alike to students and teachers G F

## Synthetic Methods of Organic Chemistry

A Thesaurus By W Theilheimer Vol 2 Translated from the German by A Ingberman in collaboration with the Author Pp xii+324 (New York and London Interscience Publishers, Inc, 1949) 60s

THE character and scope of this work, and its position among serial publications on organic synthetic methods, have been outlined in an earlier issue of *Nature* (158, 287, 1946) The German edition of Vol 2 was published in 1948 In this English translation the author acknowledges his indebtedness to various American industrial firms which have contributed towards the cost of the work because of its value to the chemical industry There will be no English editions of Vols 3 and 4, but an English key will be appended to the index of each of them The English edition of Vol 2 contains a cumulative index of thirty-eight pages, covering Vols 1 and 2 From Vol 5 onwards it is proposed to publish an English version of each issue J R

# ROYAL SOCIETY

## ANNIVERSARY ADDRESS BY SIR ROBERT ROBINSON, O M , F R S.

## AWARD OF MEDALS, 1950

### Copley Medal

THE COPLEY MEDAL is awarded to Sir James Chadwick for his pioneering researches on the constitution of matter

Sir James Chadwick was in turn the pupil, the collaborator, and the colleague of Rutherford, basking for a time in the warmth of the radiation from the master and then showing that he possessed fires of his own It is recognized throughout the world that his leadership in nuclear physics has played a most important part in the sensational developments of sub-atomic science in the last few years

In early days he was the first to find the continuous spectrum of beta-rays and the first to make an accurate measurement of the charge on the nucleus

During the First World War he contrived to prosecute some work under the difficult conditions of Ruhleben, and on returning to England joined Rutherford in significant developments of the latter's discovery of the transmutation of nitrogen brought about by alpha-rays He showed that a similar decomposition of the atoms of most of the lighter elements could be effected These experiments led to his discovery of nuclear resonances

But the greatest achievement of Sir James, and one that ensures that the name of Chadwick can only be temporarily and partly lost in his present dignity as Master of Gonville and Caius College, was his demonstration of the existence of the neutron

This discovery is transcended in importance only by that of the electron, and it has revolutionized our conceptions of the structure of the atomic nucleus It has also proved to be essential for the modern developments of the artificial transmutation of the elements, and all devices for the production of atomic energy are based on the release of neutrons in chain processes

During the Second World War, Sir James took a leading part in the scientific direction of nuclear research, while his powers of organization, gifts of leadership and ambassadorial tact were of the utmost value in promoting efficient and harmonious collaboration in the international sphere

A brilliant experimenter and a sound, but not a highly speculative philosopher, Chadwick has made contributions to physics and chemistry which are fundamental over the whole range of physical science

### Rumford Medal

The RUMFORD MEDAL is awarded to Sir Frank Whittle for his inventions relating to the production and application of power

The Rumford Medal is awarded every second year to the author of "the most important discovery or useful improvement which shall be made and published in any part of Europe on Heat or on Light, the preference always being given to such discoveries as, in the opinion of the President and Council of the Royal Society, tend most to promote the good of mankind" It is peculiarly appropriate, therefore, that the Rumford Medal can on this occasion be awarded to one whose inventive genius has shown us the way to annihilate the distances that separate the peoples of the world

Air-Commodore Whittle started his work on jet propulsion of aircraft some two or three years before the War His ideas were entirely original and extremely simple in fundamental conception He proposed to take all the air that was necessary for the propulsion of aircraft through a compressor, raise it to a high temperature by the combustion of fuel and expand it through a turbine The expansion provides all the energy for the operation of the compressor, and the kinetic energy in the exhaust gases provides the propulsive effect

The problems of design to ensure reliability as well as sufficient thermal and aerodynamic efficiency were so formidable that many engineers thought Whittle's ideas were impracticable, or at least premature Whittle, however, persevered in the face of considerable difficulties, and it is now accepted on all sides that he has developed a form of propulsion which is likely to become, with modifications, a standard method of propelling aircraft in the future

As appears to be the case with many pioneers of mechanical engineering, brilliance of inventive genius is coupled in him with great powers of drive, leadership and organization Whittle is a worthy successor of Watt and Parsons Thanks to him, the magic carpet is no longer a fantasy of an Arabian Nights Entertainment

### Royal Medals

A ROYAL MEDAL is awarded to Sir Edward Appleton for his distinguished contributions to our knowledge of the ionosphere

In 1882 Balfour Stewart predicated an electrically conducting layer at high altitudes in the atmosphere in order to explain periodic changes in the strength of the earth's magnetic field Again, in 1901, the establishment by Marconi of radio-communication between England and Newfoundland led to speculation about the mechanism of the apparent bending of radio-waves round the earth's surface It was shown that this could not be accounted for by diffraction, and the suggestion independently advanced by Kennelly and Heaviside in 1902, that it is due to the influence of a conducting layer in the higher atmosphere, seemed most probable This was not, however, generally accepted until Appleton, in 1924, gave an experimental demonstration of the reflexion of radio-waves between Bournemouth and Oxford by a layer estimated to be 90 km above the ground-level He also measured the angle of incidence of the down-coming waves

A few years later he found that this Kennelly–Heaviside, or $E$ layer, could be penetrated before sunrise, and a second layer at a height of 230 km was discovered This is justly called the Appleton layer Further refinements have led Appleton to recognize a weakly ionized layer below $E$, termed $D$, while under some conditions the Appleton layer resolves itself into two strata, $F_1$ and $F_2$

Appleton proved that ionization in the $E$-layer is caused by ultra-violet light from the sun, and was able to correlate the emission of this light with sunspot activity. More recently he has made important discoveries relating to the emission of radio-waves from the sun.

The practical importance of these discoveries in the rationalization of telecommunication, especially by means of short waves, has been very great. Moreover, the novel techniques which Appleton and his co-workers have devised as tools for their work proved fundamental for the development of radio-location and have also been applied in other fields of investigation. Appleton has greatly extended the power of man to acquire information about remote regions; he has demonstrated the existence of showers of meteorites that surpass the shooting stars, and has been in correspondence with the moon. It is remarkable how unswerving has been his course as a pure physicist in spite of so many seductive side-tracks.

A Royal Medal is awarded to Dr. Carl Frederick Abel Pantin for his distinguished researches in the comparative physiology of invertebrates.

Pantin's earlier work was concerned with an analysis of the physiological mechanism of amœboid movement. These are the classic studies in that field and form the foundation on which present investigators, using new techniques, base their work. There followed a series of admirable papers on the nature of excitation and inhibition in the muscles of Crustacea, which led to a detailed comparison between the physiology of muscular contraction in the arthropods and in the vertebrates.

In more recent years, Pantin has turned to a totally different neuromuscular system, that which is controlled by the primitive nerve net. His studies on the nerve net of Cœlenterates can properly be regarded as a landmark in the history of the neuro-physiology of the lower animals. Prior to the publication of his first paper, the relationship of the nerve net to the organized central nervous system of higher animals was extremely ill-defined; it now forms an effective canvas for a generalized picture of neuromuscular evolution.

Pantin's analysis follows on his discovery that the nerve net never responds to a single excitatory shock, however strong, but to a series of shocks the efficacy of which depends on their number and on the time interval between them. Each excitatory shock elicits a single excitatory impulse in the net; but the net does not conduct unless the original shock is followed by others at appropriately short intervals. No decrement occurs during conduction; but each group of muscles responds to a series of shocks of characteristic number and time interval. Each group of muscles can therefore be brought into action by experimental means.

These studies have also provided an understanding of the mechanism of muscular co-ordination in the normal intact animal. Different regions of the net conduct at different rates, some being as slow as 10 cm. per sec., others as high as 2 or 3 metres per sec. The study of each of these tracks has made it possible to present a comprehensive and convincing picture of the normal behaviour of the animal. Pantin's leadership in this field of work has been widely acclaimed for more than twenty years.

## Davy Medal

The Davy Medal is awarded to Sir John Lionel Simonsen for his distinguished contributions to the chemistry of the essential oils.

Over a period of about forty years, Simonsen has busily explored the rich field of the plant hydrocarbons and their oxygen derivatives. In more than two hundred memoirs he has described the isolation of new members of this group, the determination of their molecular structures, and related synthetic experiments. In some cases he has discussed the mode of formation of these plant products *in vivo*. Thus in 1920 he discovered the first naturally occurring representative of the bicyclic hydrocarbon carene, namely, *d*-$\Delta^3$-carene from *Pinus longifolia*. His hypothesis that the only known 'meta-terpene', D-sylvestrene, was an artefact originating during its process of isolation from carene received later confirmation after his discovery of $\Delta^3$-carene in the oil from *Pinus sylvestris*. Afterwards, in the oil from the grass *Andropogon Juarancusa*, he found a third carene derivative, $\Delta^4$-carene, along with the ketone, D-piperitone. This led him to the conclusion that the carene types of hydrocarbon are formed in Nature from the alcohol piperitol, which also occurs in the above grass oil. Apart from one further representative found in the oil from *Zieria Smithii*, no other derivatives of carene have ever been discovered.

Simonsen made the first observation of the natural occurrence of α-thujene, which he found in the oil from *Boswellia serrata*. He was also the first to record the occurrence in Nature of sesquiterpene ketones (in the oil from *Eremophila Mitchelli*), and in a brilliant series of experiments he was able to assign structural formulæ to them and to prove that they furnished an exception to the 'isoprene rule', although giving rise to eudalene on dehydrogenation. A further such ketone, D-cyperone, was isolated by him later and found also to be a eudalene derivative. This was synthesized, and for the first time it was shown in this synthesis that an angle-methyl group could be completely eliminated in a dehydrogenation process.

Further investigations were concerned with the sesquiterpenes such as longifolene, the caryophyllenes, curcumenes, santalols, and lanceol. Simonsen was the first to observe the existence in Nature of the β-diketones, among which are angustione and its derivatives.

Simonsen's authoritative position in this important field of work has been widely recognized and he is the author, with several collaborators, of a three-volume treatise on the subject.

## Darwin Medal

The Darwin Medal is awarded to Prof. Felix Eugen Fritsch for his outstanding contributions to the study of the Algæ.

Fritsch's earlier memoirs were concerned mainly with the investigation of algal periodicity, and his studies of seasonal changes in the algal floras of streams and ponds played an important part in laying the foundations of modern algal ecology. In the domain of algal taxonomy he has not only investigated the flora of British fresh waters but also has materially added to our knowledge of the algal floras of many parts of the world, among which special mention should be made of his memoirs on the freshwater Algæ of Africa. He has made notable contributions to our knowledge of the morphology and evolutionary trends in the algal phylum and it is true to state that he has done more than any other to develop scientific algology in Britain. His revision of West's "British Freshwater Algæ", published in

1927, was so radically extended as to constitute well-nigh a new work and throughout bore witness to his own contributions  The two volumes on "The Structure and Reproduction of the Algæ", which appeared in 1935 and 1945 respectively, are characterized by an unusual breadth of knowledge extending over the entire field of freshwater and marine Algæ , they established his reputation as a leading algologist of the world  The Freshwater Biological Station at Windermere was brought into being as the result of his efforts, initiated primarily because of his interest in algal ecology

His work is notable alike for its thoroughness and accuracy, and has provided a stimulus to research in this domain which has been effective in many parts of the world

## Hughes Medal

The HUGHES MEDAL is awarded to Prof Max Born for his distinguished contributions to quantum mechanics

Born has made many important contributions to theoretical physics, in particular to the theory of relativity, the theory of the crystal lattice and to non-linear quantum electrodynamics  In the years 1923–25, he was actively engaged in the study of quantum theory applied to atoms and molecules and their response to outside influences  The tool in this work was the use of Fourier amplitudes and the action and angle variables of classical mechanics, which, with the correspondence principle, gave expressions for observable quantities  The work on aperiodic phenomena contains the calculation of transition probabilities, and foreshadows the later work on collision processes

When Heisenberg in 1925 proposed a direct calculus for handling the quantum amplitudes, based on a generalization of the correspondence principle applied to the classical Fourier amplitudes, it was Born who recognized it as the mathematicians' matrix calculus  In collaboration with Heisenberg and Jordan, Born developed the matrix mechanics into what is essentially its final form and applied it to the elucidation of many physical problems of importance in atomic and molecular physics

Following the recognition by Schrodinger that the content of wave mechanics was identical with that of matrix mechanics, Born analysed collision processes by wave-mechanics, thereby linking up with his previous work on aperiodic phenomena  He showed that the physical interpretation demanded that the squared modulus of the wave function should be considered in terms of probability and not as a continuous distribution of charge, as had been supposed by Schrodinger  This work also contains a method of evaluating collision cross-sections by successive approximations, of which the first is the now famous Born approximation

In collaboration with Oppenheimer, Born treated the wave mechanics of molecules, giving the formal justification for the separation of the motion into three parts, electronic, vibrational and rotational  He also placed the adiabatic principle of Ehrenfest on the footing of a deduction from quantum mechanics, thereby filling a gap in quantum statistical mechanics

His work, of which only a small part has been mentioned, has been characterized by profound insight and has always been clearly related to problems of the real physical world

## A NEW SCIENCE CENTRE IN LONDON

A year ago I stated that it might be possible at this anniversary meeting to discuss the course taken by our negotiations with the Government on the most important of our current activities, namely, the improvement of the accommodation of the scientific societies  This hope has been fulfilled, and it can be announced with confidence that very substantial progress has been made  All the fundamental aspects have been agreed in principle and, if we are now to be disappointed, it can only be as the result of some grievous calamity

In his presidential address of 1943, Sir Henry Dale gave a full and most interesting account of the history of the housing of the Royal Society  He directed attention to the whittling down of our earlier prospects at Burlington House and to the fact that our quarters here were found to be inadequ[illegible] so long ago as 1900  His address concluded with an eloquent reminder of the essential part played by science in our national life and in defence , and he pointed out that it was the duty of scientific men to advance early claims for the conditions which will make it possible for them to discharge their responsibilities to the country, and on the higher plane, to make the most effective contributions to knowledge and human prosperity and happiness

At that time the better use of Burlington House was not considered impracticable, but failing that, a plea was advanced for the re-vitalization of a project of 1851, the establishment of a Science Centre in London  Sir Henry's last sentence was the following "I think that we have the  right to expect that the home of science, in this capital city, will have a dignity symbolizing its value to the nation and the empire, and enabling us to hold up our heads in the company of other countries, whose scientific academies, not more famous than ours, have so long been housed more worthily, and with a more generous recognition of their due place in an enlightened people's scale of values"

On October 13, 1944, Mr C R Attlee, then Lord President of the Council, Sir John Anderson, Chancellor of the Exchequer, and Lord Portal, Minister of Works, received a very representative deputation from the learned societies of London  The main object was to bring to notice the needs and claims for accommodation of the societies which aim at the promotion of the independent advance of the fundamental sciences  This was supported by references to the historical background and to the actual needs of the societies, which had quite grown out of their shoes

The members of the deputation were assured of the interest of the Government in their submissions, and a memorandum was drawn up by Sir Alfred Egerton. This stated that the result of the meeting with the Ministers was that Sir Henry Dale was asked to submit the needs of the scientific societies in quantitative form, and that the Government would then consider what might possibly be done about it  Many of the detailed suggestions that followed were explored by the officers of the Royal Society but with no satisfactory outcome apart from the accumulation of information and an increasing conviction that a radical solution of the problem could not be found at Burlington House

The Scientific Societies Accommodation Committee was set up in 1947 in order to review the alternative schemes that might be suggested and to arrive at as close an estimate as possible of the needs of the societies Representatives of the participating societies were empowered to communicate directly with the officers and councils of their respective bodies while the Committee as a whole reported to the Council of the Royal Society We have thus been in a position to bring all the interests to a focus

An examination of the feasibility of adequate extension of facilities in Burlington House, or nearby, led to no satisfactory result, and this idea was reluctantly abandoned Emphasis then shifted to the conception of a Science Centre, and this was accepted by the Committee and Council as offering by far the best solution of our problems

Various proposals in connexion with particular sites have been considered, and one of these was so nearly adopted that it led to a careful study of the desirable content of the Science Centre

So far as the scientific societies are concerned, the following is the agreed present list of participants Biochemical Society, British Association, Chemical Society, Faraday Society, Geological Society, Linnean Society, London Mathematical Society, Physical Society, Physiological Society, Royal Anthropological Institute, Royal Astronomical Society, Royal Meteorological Society, Royal Society, Royal Statistical Society, Society of Chemical Industry In addition, it is well understood that many of the smaller scientific clubs and societies will receive hospitality in the future under the new arrangements, as they do at present and have done in the past In general, these very useful and enthusiastic groups, such as the local entomologists and the microscopists, do not require offices and can hold their meetings at convenient times by arrangement

The Society of Antiquaries of London came to Burlington House from Somerset House at the same time as the Royal Society, and at our instance It was therefore with very great regret that I received a few weeks ago a letter from the president, Sir James Mann, who has been a valued member of the Accommodation Committee, to the effect that the Society of Antiquaries does not wish to participate in the Science Centre I should say that somewhat different words were used, but that is their content Sir James Mann adds "I should like to express on behalf of this Society our very deep regret that the connection between your Society and ours should be severed after so many years of close proximity, both at Somerset House and at Burlington House There was a time when certain distinguished individuals filled the office of President of both Societies In view of the great advances which modern science has made in recent years, it is very unlikely that this happy situation will occur again, and the divergence between the arts and archæology on one hand and the natural sciences on the other will tend to increase The Society of Antiquaries feels that it must throw in its lot with the Societies concerned with the Humanities, to which it is more closely bound We hope, however, that the cordial relations which have always existed between us for over two hundred years will remain, even though we may be more distantly placed geographically "

We are not at all convinced that the gap between archæology and the natural sciences will tend to increase, but we do most warmly reciprocate the brotherly sentiments of the Antiquaries

Each scientific society was asked, through its representatives, to furnish a statement of needs in terms of meeting rooms, library space, and offices In addition, common ancillary services were considered such as a congress hall, certain lecture theatres, canteen and so forth Allowing for reasonable expansion, the floor-space required was found to be 300,000 sq ft

After these preliminaries had been agreed, we sought a second interview with His Majesty's Ministers, and on July 7, 1948, a deputation was received by the Lord President of the Council, the Chancellor of the Exchequer and the Minister of Works We were much encouraged by the sympathetic reception of our proposals, and detailed arrangements were made to carry the project to a further stage This resulted in a series of negotiations with officials of the Ministry of Works and especially in a meeting at Lambeth Bridge House on April 28, 1949 However, the particular scheme which was then discussed lay in abeyance, and was eventually abandoned

Reverting to the meeting of July 1948, we were at that time given to understand that the Government was prepared to acquire a site and make a contribution towards the cost of building, but that the building must be the societies' own responsibility We pointed out that this would mean indefinite postponement, except perhaps for some of the societies which have close associations with industry, and expressed the hope that the Government would later find it possible to reconsider this attitude and provide the site, the buildings and rent-free accommodation in them

In the early autumn of the present year we were told that the scheme for a Science Centre had made great progress An adequate, central site had been selected, and the Treasury had most generously offered to provide the cost of building.

In the House of Commons on November 21, in reply to questions put by Mr M Phillips Price and Sir Wavell Wakefield, the Lord President of the Council made a statement as follows

"I am glad to say that since this matter was raised on 5th May last by my hon Friend the Member for Walsall (Mr W Wells), it has been possible to overcome the remaining obstacles for the adoption of the long-term proposals originated by the Royal Society for a British Science Centre in London To prevent any misunderstanding, I must emphasize that it will be some years yet before my right hon friend the Minister of Works can build such a centre, but a start will be made on it as soon as resources can be found, having regard to other urgent claims Provision will be made for accommodating within the area the Patent Office and its Library, which will be modernized and extended as a first-rate central reference library on science and technology

"Suitable new quarters will be built for the Royal Society and for other leading scientific societies with their important special libraries, most of which are now severely cramped in the rooms provided for them by the Government not far short of a hundred years ago in Burlington House, or in other inadequate accommodation New offices for the Department of Scientific and Industrial Research and other Government scientific organizations will also be provided By this means buildings elsewhere will be released for other uses, and some economies in building requirements will be achieved

"The Centre will be designed to improve facilities and contacts between scientists and users of science, both nationally and internationally Much detailed planning remains to be done, but it may be convenient for the many interests affected to have this preliminary advance statement I hope to announce the selection of a site as early as possible in the New Year, but it will be some time yet before a final scheme can be developed "

In the House of Commons, Mr Price, who is chairman of the Parliamentary and Scientific Committee, assured the Lord President that his answer would give great satisfaction to scientific societies throughout the country and to the Parliamentary and Scientific Committee

A similar statement was made in the House of Lords by Viscount Addison in reply to a question put by the Earl of Perth

In the interval between the first communication of this development and the welcome announcement of the Lord President of the Council, steps were taken to acquaint the Scientific Accommodation Committee and officers and councils of the various societies with the details of the new project in so far as they were known Concurrence was indicated in each case, either by a resolution of council or the best available equivalent

Here I must plead *peccavi* and ask for absolution in that I stated in 1948 that the Fellowship of the Royal Society would be consulted just so soon as the issue could be put to them in a precise form This has not been feasible in view of the extremely complicated character of the negotiations which involved many parties Even at the present stage, the issue cannot be completely defined and it was early apparent that no advance at all could be made on the basis of awaiting a clear-cut scheme It was necessary to proceed by successive approximations, and that implied the exercise by the Council of its statutory authority as the executive of the Society at the various stages, the last of which has not yet been reached

A memorandum by the Foreign Secretary of the Society, who has just been elected as President, was forwarded with the approval of Council to the Lord President of the Council In it the importance of maintaining the prestige and independence of the Royal Society was emphasized, and some of the conditions for securing this in a Science Centre were defined The Lord President has indicated his full concurrence with these views and I may also say that throughout our negotiations the vital importance of maintaining the traditional character and dignity of the Royal Society has been kept in the forefront I have seen no sign whatever of any attempt, or desire, to undermine our independence or to make us subservient in the smallest degree to some material or political interest On the contrary, the great national value of the Society as a focus of the scientific activity of the Commonwealth is recognized, and one main object of the establishment of a Science Centre is to provide the physical conditions in which we may better spread our wings and soar to even greater heights

Turning to the broad outlines of the project itself, the first point to notice is that the location of the site has not been published The Lord President thinks he may be able to give this information early in the New Year Nevertheless, our discussions have been on the basis of a particular site, and the concurrence of the scientific societies, including the Royal Society, has been given in relation to this site

I am disappointed that it is not possible for me to enlarge, as I would have wished to do, on the contribution which the Science Centre building should make to the aspect of the new London Nor can I expatiate on the famous landmarks that may be visible from its windows Suffice it to say that we believe the site, when finally selected and approved, will be found to be entirely satisfactory, not only in area, but also in position There is no doubt that it will offer a great opportunity to an imaginative architect, and it will be easily accessible from other parts of London In the latter respect, Burlington House sets so high a standard that we can scarcely expect to maintain it in a new Science Centre of adequate size

It is probable that the scientific societies will be housed in a worthy and impressive building, such a one as could look Somerset House in the face, and it is agreed that this will have the most prominent position on the site The quarters for the various societies will be separate, with their own entrances, very mu in the same way as here at Burlington House

All these questions need further elaboration, and the placing of ancillary services, probably including a club for scientific men, is dependent on the general design

We have every reason to believe that the buildings will be noble in conception and that the materials, construction and workmanship will be of the highest class An eminent architect will be chosen, it has been agreed that the Lord President will be consulted in this matter and we are also confident that our views will be ascertained and given due weight in reaching the decision The scientific societies will retain their individual libraries, together with any system of classification to which they attach importance There will, however, be a Central Scientific Reference Library based on the Patent Office Library, with which the societies are asked to co-operate in every possible way

This and other developments on the Science Centre site will be housed in separate buildings, and we may look forward to a convenient proximity of parallel activities which may well grow continuously in the future

The project is certainly not a short-term one, and yet we venture to hope that long-term is too pessimistic an expression The tercentenary of the foundation of the Royal Society has been fixed by the Tercentenary Commemoration Committee to occur in 1960 I have looked up a part of the evidence* on which this conclusion was based and there can be no doubt of its correctness can be advanced. The point I now wish to make is that if such a tropolone section of the molecule were to suffer reduction, a re-formation of the six-ring could lead to the structure of yohimbine (part-formula, VIII).

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* Extract from the *Journal Book* of the Royal Society, 1660–63 "Memorandum that November 28th 1660 These persons following, according to the usuall Customes of most of them, Mett together at Gresham Colledge to heare Mr Wrens lecture, viz The Lord Brouncker, Mr Boyle, Mr Bruce, Sir Robert Moray, Sir Paul Neile, Dr Wilkins Dr Goddard, Dr Petty Mr Ball Mr Rooke, Mr Wren, Mr Hill And after the Lecture was ended they did according to the usuall Manner, withdrawe for mutuall converse Where amongst other matters that were discoursed of, Something was offered about a designe of founding a Colledge for the Promoting of Physico-Mathematicall Experimentall Learning

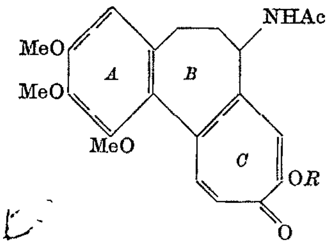
"And because they had these frequent occasions of meeting with one another, it was proposed that some course might be thought of, to improve this meeting to a more regular way of debating things, and according to the Manner in other Countries, where there were voluntary associations of men into academies, for the advancement of various parts of learning, So they might doe something answerable here for the promoting of Experimentall Philosophy "

It was then agreed that the weekly meetings should be continued and a subscription of ten shillings down and one shilling a week was fixed Later in the same year Officers were selected, that is to say a President or Director, a Treasurer, and a Register At this stage the President was chosen monthly but very wisely the Treasurer persisted for a year

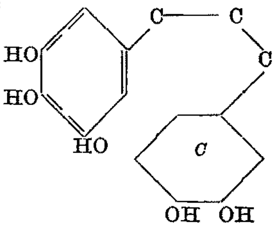
On December 5, 1660, the following memorandum was entered "This day Sir Robert Moray brought in word from the Court that the King had been acquainted with the designe of this meeting And he did well approve of it, and would be ready to give an encouragement to it "

On March 6 1660 "Sir Robert Moray Chosen President" It should be recalled that the New Year started on March 25

One of the most remarkable of the tropolone derivatives is the alkaloid colchicine (IX, or transpose O and O*R*).



IX



X

Owing to the disposition of nitrogen in the γ-position to the phenyl nucleus, this structure can only with the greatest difficulty be related to the phenylalanine group. Mr. F. A. L. Anet has combined two of my own postulates and made the interesting suggestion that colchicine is derived from a $C_6$—$C_3$—$C_6$ progenitor (X) by simple and acceptable processes *plus* the above ring-enlargement of ring *C* to the tropolone.

On this view the base is more closely related to the anthocyanins than to the alkaloids. Little is known about the tannins, anthocyanins, anthoxanthins, etc., of *Colchicum autumnale* L., and it is desirable that a full examination of them should be made.

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# RADIOACTIVE STANDARDS AND UNITS

By Prof. F. A. PANETH, F.R.S.

EARLY in the history of radioactivity the need for standards was felt; without them the results obtained in different laboratories could not be compared, and the application of radioactive rays in therapy lacked a reliable foundation.

Under the presidency of Lord Rutherford, and with S. Meyer as secretary, an International Radium Standard Commission was constituted; the other members were B. Boltwood, Mme. P. Curie, A. Debierne, A. S. Eve, H. Geitel, O. Hahn, E. v. Schweidler and F. Soddy. In 1912 the Commission decided to acquire a preparation of the purest radium chloride ($RaCl_2$), made for this special purpose by Mme. Curie, and to declare it to be the international standard, to be used exclusively by members of the Commission; it weighed 21.99 mgm. At the same time the Vienna Academy of Sciences was asked by the Commission to guard as the second international standard, under the same restricting regulations, one of three radium chloride preparations made by O. Hoenigschmid; the one chosen by the Academy contained 31.17 mgm.

It is, of course, very unusual to have more than one international standard of anything. This procedure was, however, justified in the case of radium standards because of the difficulty of the measurements involved. Once prepared, the standards had to be kept in sealed glass tubes; while the weight of the preparations could probably be relied upon to an accuracy of one in a thousand, the gamma-ray measurements which had to be used for all comparisons could not be guaranteed to better than about 0.3 per cent. Within this accuracy, the two international standards showed no difference when compared in Paris in 1912 by members of the Commission; but the actual agreement was most likely better than could at that time be proved by gamma-ray measurements. If an unknown quantity of a more or less chemically pure radium salt had to be measured with the highest possible precision—for example, for the calibration of one of the 'national' radium standards—the most reliable line of conduct was to carry out these gamma-ray measurements quite independently, and with somewhat different instruments, at the Laboratoire Curie in Paris and at the Radium Institute in Vienna, using their respective international standards. Each of the official certificates of the national standards bears witness to this procedure; the final figure given therein is the mean of the two calibrations. It was customary to call 'primary' radium standards those defined by precision weighing of a quantity of purest radium salt, and 'secondary' standards those measured by gamma-ray comparison with a primary standard. The radium contents of both were expressed in grams of radium element.

Another unit had to be introduced for the standardization of radon—a radioelement of at least equal importance for medical use—since it was impossible to weigh or, for that matter, to measure volumetrically such minute quantities of gas with any accuracy. The gamma-ray comparison of radium salts was, strictly speaking, always a measurement of the gamma-rays of radium C, after radon and the active deposit had reached equilibrium with the radium; it was therefore quite natural to express radon quantities by the weight of the radium with which they were in radioactive equilibrium. At the International Radiological Congress at Brussels in 1910, one 'curie' of radon was defined as the quantity of radon in equilibrium with one gram of radium (element). Soon it became customary to speak also of curies of radium C, etc.; it meant always the quantity in equilibrium with one gram of radium. In 1930 the International Radium Standard Commission recommended officially that the use of the term 'curie' be extended to include the equilibrium quantity of any decay product of radium; but the Commission did not favour its extension to radioelements outside the radium family. On the other hand, it stated that the unit quantity of any radioactive element might be expressed in terms of the mass which is equivalent to one gram of radium, either with respect to the effect of the rays, or to the number of atoms decaying per second. The first procedure was, for example, used in specifying quantities of mesothorium by the weight of radium giving an equivalent intensity of gamma-rays; in the latter sense, one could define 1 gm. of radium-equivalent as that quantity of any radioactive element for which the number of atoms decaying per second was the same as that in 1 gm. of radium. It was recommended by the Commission that one should provisionally use as this number the value $3.7 \times 10^{10}$ disintegrations per second; but this figure was not known with an accuracy of less than 0.5 per cent and did not form part of any definition.

Since those days, two important developments have taken place: the production of artificial radio-elements of great practical importance, and the construction of apparatus which makes counting of emitted particles a routine operation. The strength of a source of, let us say, radioactive phosphorus or iodine could conveniently be expressed by the number of emitted particles, but it was usually preferred to give the result in curies, using $3 \cdot 7 \times 10^{10}$ as conversion factor.

This habit was not satisfactory in view of the fact that the curie was strictly defined only by the weight of a radium salt, and that its disintegration-rate was still open to discussion. The situation was aggravated in 1947 by a new determination of the number of atoms disintegrating per second in one gram of radium, claimed to be considerably more accurate than the previous ones; it reduced the figure to $3 \cdot 6 \times 10^{10}$. The acceptance of this new value was recommended in July 1948 at a meeting in Amsterdam of the International Union of Physics[1]; but the authority which would have had to sanction this recommendation, the International Radium Standard Commission, had practically ceased to function, in spite of the devotion of Prof. Stefan Meyer in Vienna, who had been elected president of the Commission after Lord Rutherford's death in 1937 and who, up to his own death in 1949, remained deeply interested in all questions of radioactive standardization.

Following an informal discussion of chemists and physicists in London in July 1947[2], the International Council of Scientific Unions in 1948 asked the International Union of Pure and Applied Chemistry and the International Union of Pure and Applied Physics to nominate six representatives each to a new Joint Commission on Standards, Units and Constants of Radioactivity; the Union of Chemistry was to be considered as the mother union of this Commission. The first meeting of the Joint Commission took place on September 8, 1949, in Amsterdam, the second on July 17, 1950, in Unesco House in Paris. At this last meeting, after some discussion, unanimous agreement was reached on the following *new definition of the curie*:

> The curie is a unit of radioactivity defined as the quantity of any radioactive nuclide in which the number of disintegrations per second is $3 \cdot 700 \times 10^{10}$.

In French, the other official language of the Commission, this definition would be:

> Le curie est une unité de radioactivité définie comme la quantité d'une nuclide radioactive quelconque dans laquelle le nombre des désintégrations par seconde est $3 \cdot 700 \times 10^{10}$.

It is to be noted that this new definition completely severs the former special connexion of the curie with radon and radium. The value $3 \cdot 700 \times 10^{10}$ disintegrations was chosen because it was the intention of the Commission to keep the new curie as near as possible to the old value of this unit. It was not felt that the measurement leading to the figure $3 \cdot 6 \times 10^{10}$ was sufficiently more convincing than the older determinations which had been the basis of the generally accepted value of $3 \cdot 7 \times 10^{10}$ disintegrations; nor did it seem necessary, or advisable, to introduce a further unit based on $10^6$ disintegrations per second; before the constitution of the Joint Commission of the International Council of Scientific Unions, such a unit had been advocated under the name of a 'rutherford'[3].

It must be kept in mind that the fundamental radium standards in Paris and Vienna are defined by the weight of radium, and cannot now be expressed accurately in curies (in the new sense of this term). These primary radium standards, and the secondary standards derived from them, are still indispensable if one has to measure radioactive substances which cannot be 'counted' but only compared by their gamma-rays; they will have to be employed, for example, for the measurement of the many radon preparations in medical use. Theoretically, the strength of such a source should now be given only in terms of its equilibrium quantity of radium in grams; but for all practical purposes it will still be permissible to equate 1 gm. of radium with 1 curie, until new determinations show that the chosen figure $3 \cdot 700 \times 10^{10}$ does not correspond with sufficient accuracy to the number of alpha-particles emitted per second; it will then be easy to use a small correction factor. Experiments to determine with high precision the 'curie value' of 1 gm. of radium, that is, the number of atoms disintegrating per second, are under way. The figure for the half-life of radium and other important constants of radioactivity depend on it.

The position with respect to the two international radium standards is as follows. Since it is not safe to keep a radium salt of some strength sealed up in a glass tube for an indefinite time, because of the accumulation of gas which may exert after a while a dangerous pressure, both original international standards were replaced, in 1934, by new standards prepared by Hoenigschmid in connexion with his second, and still more accurate, series of atomic weight determinations of radium. The new standard in Paris contains 22·23 mgm. radium chloride and the new standard of the Austrian Academy of Sciences 30·75 mgm. The former used to belong to the International Radium Standard Commission, but, with the consent of all the surviving members of this Commission, has now been transferred into the ownership of the new Joint Commission on Standards, Units and Constants of Radioactivity. It will remain under the care of the Bureau International des Poids et des Mesures at Sèvres, but may be kept in the Laboratoire Curie in Paris; the Vienna standard is permanently housed in the Institute for Radium Research.

The Joint Commission discussed the possibility of making use of artificial radioactive isotopes for secondary gamma-ray standards, and recommended that samples of cobalt-60 should be prepared by several laboratories and exchanged for comparison; but the time does not seem ripe for using this nuclide as a radioactive standard at the international level, since its half-life is not yet known with sufficient accuracy. For beta-ray standards radium E (in equilibrium with radium D), strontium-90 and thallium-204 seem promising, but here again it was the opinion of the Commission that it would be premature to take an international decision. Attempts to prepare such standards for distribution were encouraged since they would be very valuable for the calibration of counting-equipment in absolute units.

Among other topics discussed at the Paris meeting of the Joint Commission was the adoption of the term 'barn' for $10^{-24}$ cm.$^2$ as a unit of cross-section for nuclear processes; the Royal Society had asked the Commission to give its opinion on this question. It was felt that there is not any new unit involved which would demand an international definition, but that the expression 'barn' in the above sense should be accepted since it is in common usage in the United States

Of the surviving members of the last International Radium Standard Commission, Sir James Chadwick, O Hahn, S C Lind and A Piccard have joined the new Commission as advisory councillors, and to replace S Meyer, the present director of the Vienna Radium Institute, Prof Berta Karlik, has also been invited to become an advisory councillor It is hoped in this way to secure for the deliberations of the Joint Commission the assistance of these experts, if required The members of the Joint Commission on Standards, Units and Constants of Radioactivity* are as delegates of the International Union of Chemistry, Miss E Gleditsch (Norway), G Hevesy (Sweden), W C Johnson (United States), F Joliot (France), F A Paneth (Great Britain, *president*), G T Seaborg (United States), and as delegates of the International Union of Physics, Sir John Cockcroft (Great Britain), L F Curtiss and R D Evans (United States), J C Jacobsen (Denmark), Mme Joliot-Curie (France) and G J Sizoo (Netherlands, *secretary*)

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* In the recently published "Description of the International Council of Scientific Unions" (Cambridge, 1950) there are several mistakes in the membership list of this Commission

[1] *Nature*, 164, 263 (1949)

[2] *Nature*, 160, 778 (1947)

[3] *Science*, 103, 712 (1946), *Phys Rev*, 77, 142 (1950)

# OBITUARIES

## Prof. Samuel Sugden, F.R S.

THOSE who had the privilege of being associated with Samuel Sugden will feel his death, which occurred on October 20, with a sense of sharp personal loss Born in Leeds in 1892, he attended Batley Grammar School, and, the bent of his mind towards science having already declared itself, he entered the Royal College of Science in 1912 and gained the A R C S in 1914 At the outbreak of war he joined the Forces and served in France Later he was engaged on work in the Research Department of the Royal Arsenal at Woolwich

In 1919, Sugden joined the Department of Chemistry at Birkbeck College, London, where he was destined to spend many happy and fruitful years, first as lecturer, later as reader and finally as professor of physical chemistry At Birkbeck he pursued with striking assiduity and success the researches on the parachor with which his name is linked Sugden made improvements in the measurement of surface tension, used the equation of D M Macleod to introduce the parachor and demonstrated the value of this property in the general revision of formulæ which followed on the adoption of the electronic theory of valency Somewhat later, stimulated by the theoretical predictions of L Pauling on the stereochemistry of 4-covalent atoms, he prepared the nickelous derivative of benzyl-methylglyoxime and showed that it occurred in two isomeric forms Finally, he found that these compounds were diamagnetic and thereby gave strong confirmation of Pauling's theory that such nickel complexes would be planar and diamagnetic

On the retirement of Prof F G. Donnan in 1937, Sugden was appointed to a chair of chemistry in University College, London In a comparatively short time he established a vigorous research school engaged on problems relating to structural chemistry and reaction mechanism

Sugden was always a good citizen willing to give public service, so that the outbreak of the Second World War found him eager to undertake work of national importance There is no doubt that the vigour with which he discharged the duties entrusted to him undermined his health and led to his untimely death

Sugden had the gift of lucid exposition which he turned to good account in the well-known books which have helped a generation of chemists As a teacher and director of research, he established the feeling that pupil and teacher were setting out together on an exciting adventure, and none but the dullest could escape the influence of his infectious enthusiasm The Chemical Society of London strongly commanded his loyalty and he served it well as honorary secretary, chairman of the Publication Committee and vice-president

Small in physical stature, he was great in heart and mind. Whether in the laboratory or at home, he was eminently sociable, radiating warmth and good humour Those who really knew Sugden will think of him as one who combined, in a rare degree, zest for intellectual adventure, physical bravery and gentle kindliness WM WARDLAW

## Prof H C Bazett, C B E.

PROF HENRY CUTHBERT BAZETT, who died suddenly at sea on July 12 while travelling to attend the International Physiological Congress, had held the chair of physiology in the University of Pennsylvania since 1921, and was at the time of his death president of the American Physiological Society

Bazett was born in 1885, son of Dr Henry Bazett, of Gravesend, he went to Dover College and afterwards to Wadham College, Oxford After qualifying in medicine he was awarded a Radcliffe travelling scholarship, and spent the year 1912–13 at Harvard During the First World War, he displayed the courage which was such an outstanding feature of his character, and was awarded the M C and was mentioned in dispatches three times He also started on his observations on man, as shown by his early papers on blood transfusion and shock After the War, he returned to Oxford as lecturer in clinical physiology and was appointed a fellow of Magdalen College, being in this respect senior to Sherrington He, and others who had returned from France, proved to be rebellious spirits and did their utmost to introduce reforms in what they considered to be outmoded aspects of the University His interest at this time was primarily in the clinical aspects of physiology, particularly in the fields of surgery He was unable to obtain the post that he desired and accepted the offer from the University of Philadelphia of the chair of physiology, the position he occupied for twenty-nine years

At Philadelphia, Bazett built up a world-famous department, devoting himself essentially to human physiology, developing both fundamental and applied aspects His main work was on temperature regulation and hæmodynamics These might well be considered two separate and distinct subjects, but they were very happily married by Bazett This was particularly well shown by his recent work on the role of the venæ comites. The anatomical arrangement of these veins provides an excellent mechanism for the exchange of heat between arterial and venous blood Bazett showed, by introducing thermocouples into arteries and veins, that such heat exchange takes place, particularly in a cold environment Cold venous blood drains from hands and feet via the venæ comites and so cools the blood passing alongside in the artery There may be a drop of 5°–6° C in the temperature of the blood from axillary to brachial artery, the venous blood, on the other hand, is warmed and may be in thermal equilibrium when it reaches the axillary vein In a hot environment, on the other hand, the main venous draining is via the superficial veins, with an increased heat loss from the overlying skin and cooling of the venous blood If this work is confirmed, it would establish an important venomotor reflex mechanism in temperature regulation

Bazett's other studies included detailed work on the acclimatization of man to various environments He was the first to establish clearly that an increased blood volume is an important feature of acclimatization to heat, a finding which at first aroused considerable scepticism, but has since been amply confirmed

In his work and writings he did not play for safety, but was prepared to be boldly speculative As a result, Bazett was an exceptionally stimulating colleague and particularly encouraging to young workers He was always ready, in fact eager, to discuss ideas and suggestions with his juniors, however naive they might be He never retired to the position of elder scientist In fact, in his physiological approach he never seemed to grow old, maintaining a zest and an exuberance which made it difficult for much younger workers to keep up with him either mentally or physically

His advice was continually requested on both sides of the Atlantic during the Second World War His unselfishness was shown by his readiness to accept the, to many workers, unpalatable task of applying his work to practical problems He was the leader of the splendid group of Canadian workers in Toronto who made such outstanding contributions in all aspects of applied physiology for the Services.

Bazett's services were in great demand for committee work he carried out his responsibilities as member and frequently chairman, not perfunctorily, but with lively and happy discussion

Bazett was due to retire from his chair in a year's time He then planned to spend his time writing, although he published many papers in his life-time, he did not manage, as he looked forward to doing, to discuss his work and ideas in a more comprehensive form He was the author of the section on the circulation in Philip Bard's edition of Macleod's "Physiology in Modern Medicine", and he contributed the chapter on "Temperature Regulation" in "The Physiology of Temperature Regulation and the Science of Clothing" edited by L H Newburgh, recently published O G. EDHOLM

WE regret to announce the following deaths

Sir Frederick Bain, deputy chairman of Imperial Chemical Industries, Ltd, chairman in 1941 of the Chemical Control Board at the Ministry of Supply, on November 23, aged sixty-one

Lieut -Colonel W G Liston, C I E, of the Indian Medical Service, during 1925–47 bacteriologist, Royal College of Physicians of Edinburgh, known for his work on the relation of rat fleas to the transmission of plague, on October 18, aged seventy-seven

# NEWS and VIEWS

## William Sturgeon, 1783–1850

ON December 4 the centenary occurs of the death of William Sturgeon, the Lancashire shoemaker and artilleryman, who by his own exertions gained for himself a place in the roll of honour beside Volta, Ampère, Arago, Oersted and Faraday His imperishable donation to science, as Sir Ambrose Fleming called it, of the electromagnet, was but one of his gifts to mankind, for by his writings and inventions he added many novelties to electrical science and stimulated the work of others Never a man of means and towards the end of his life as poor as he began, he gave freely of his talents, never did a private soldier make better use of his time He was the son of a shoemaker of somewhat idle habits, and the apprentice of another of still less amiable qualities At the age of nineteen he left the shoemaker's bench to become a militiaman, and a year or two later transferred from the Westmorland Militia to the Royal Artillery at Woolwich, which remained his home for nearly forty years He was discharged from the Army at the age of thirty-seven with a pension of a shilling a day He resumed his trade at 8 Artillery Place, Woolwich, but his workroom became his laboratory and it was there he made the first electromagnets worthy of the name, for which in 1825 the Society of Arts awarded him a "Silver Medal and Thirty Guineas as a Bounty" Stimulated no doubt by the scientific atmosphere of the Royal Military Academy, Sturgeon taught himself mathematics and classics, made experiments which appealed to the cadets, and later on became a lecturer, first at the East India Company's Royal Military Academy, Addiscombe, near Croydon, then at the Adelaide Gallery of Practical Science, situated at the west end of the Strand, London, and then at the Royal Victoria Gallery of Practical Science at Manchester

Sturgeon was born at Whittington in north Lancashire on May 22, 1783, and was fifty-seven when he became superintendent of the Royal Victoria Gallery at Manchester, but he had lost none of his vigour and power of lucid exposition However, the Gallery soon closed its doors, and Sturgeon fell on evil days His invention of the electromagnet and of the electromagnetic motor, his many original observations, his memoirs, his "Annals of Electricity", his friendship with Joule and other things will cause him long to be remembered He died at Prestwich, Manchester, on December 4, 1850, at the age of sixty-seven and was buried there, afterwards his admirers placed a marble tablet to his memory in the church of Kirkby Lonsdale, Westmorland, near which he had passed his youth "Beyond any question," said Fleming, "his name must be inscribed in the records of those whose labours have enabled us yet more to utilise the great energies of Nature for the use and benefit of mankind "

## Measurement of Human Performance

For many years psychologists have been interested in the specific and general causes leading to the observed diminution of efficiency in behaviour concerned with regular adaptation to a repeated stimulus Certain generalizations seem to be valid , for example that after some time efficiency decreases, though not always regularly, and that various, apparently irrelevant, circumstances can affect the results These studies have been limited, however, and no investigator has had a sufficiently large sample of subjects nor adequate controls In the Special Report Series No 268 of the Medical Research Council, "Researches on the Measurement of Human Performance", by N H Mackworth (pp 156 , London H M Stationery Office, 1950 , 4*s* net), the study reported had the advantage of being urgently required by the Armed Services, since during the Second World War there was much work involving prolonged visual search both with the naked eye and with the aid of radar screens Obviously, continued accuracy was essential A series of tests for visual and auditory vigilance was devised as nearly as possible reproducing the real situation, and the subjects were from the Services The tests and the conditions involved are described in detail, and many of them might be adapted to the similar or related problems existing in other fields Statistics are given showing the effect of different periods of duty, of knowledge of the results, of the effects of 'Benzedrine', of individual differences and of high atmospheric temperatures The second part of the work gives the results of the study of environmental stress, for example, the effects of tear gas and of arsenical smoke, and further studies of high temperatures The results are analysed in detail and the inter-relationship between physical, physiological and psychological findings clearly brought out This scholarly and scientific report is a valuable contribution to knowledge both from the practical and theoretical points of view

## Group Behaviour

The sixteenth issue of *Science News* contains an interesting article by G R Taylor on group dynamics After reviewing recent work on the mechanics of group psychology, Taylor suggests that behaviour is not simply a product of personality, as has always been assumed, but is the product of interaction between personality and the culture of the group The implications of this conclusion are far-reaching and mean that, if we wish to obtain higher output from industrial workers, we have to study not only individual motivation ('incentives') but also the dynamics of the work-teams and factory groups in which they find themselves It is also suggested that there is a valid sense in which a group may be said to have a life—intentions, anxieties and patterns of behaviour—which is distinct from the life of the individuals composing it The next stage in the study of group behaviour is an exhaustive analysis of a few representative groups in terms of all the known variables, to establish whether they are adequate to give a complete account of what goes on in the group. In another article D W Davies suggests that, given the necessary time for computation, games of chess and other two-person games can only lead to foregone conclusions as in noughts and crosses. Stanley Byard also gives an account of robots which play games, while Prof H Hartridge concludes his previous article on human colour vision. Besides other articles, there is the usual research report by Arthur Haslett

## Use of Mechanical Power in Agriculture

In his address to the Farmers' Club at a meeting held in the Royal Empire Society's Hall, London, on November 6, Mr. W H Cashmore chose the subject of a "Survey of Power on the Land" After showing how rapid has been the advance in mechanization in Great Britain since 1939, Mr Cashmore went on to discuss the general trends in this direction at the present day, emphasizing in particular the necessity for a reduction in working costs Improvements have been made in the handling of hay, silage and grass for drying One-man pick-up balers have already speeded up the collection of hay sixfold, and a recently introduced self-propelled machine can increase the rate still further, while the value of bruising machinery to hasten the natural drying process and so reduce the risk of damage to quality is being tested Other new developments in grass conservation are one-man outfits for collecting silage material and automatic feeding devices for grass-drying plants Although improvements in technique have lowered the average surplus moisture in grain harvested by combine, considerable attention still has to be paid to the subsequent drying processes, and two methods, the sack platform drier and the silo drying installation, have been established as satisfactory for this purpose. Machines for harvesting root crops are being more extensively used, and from trials carried out by the National Institute of Agricultural Engineering it seems that, as regards potato lifting, work should proceed with a two-row machine depositing the tubers on the ground as well as with complete harvesters The needs of the small farm present a special difficulty, and versatile machines such as the universal root harvester are of particular value here Though there are indications that a phase of stability in design is being reached, some new machines, such as one that combines drills and fertilizer placement, and a one-way plough, are still needed The prospects of a decrease in capital outlay are not hopeful , but if greater attention is paid to reliability and simplified maintenance and to the elimination of weak component parts, there is no doubt that working-costs can be materially reduced

## Supply of High-Purity Metals in Great Britain

On several occasions and particularly during the Second World War, important research projects in Great Britain have been delayed through lack of metals of suitable purity, and to obviate this in future the Department of Scientific and Industrial Research, through its Chemistry Research Board, set up a Pure Metals Committee The task of this Committee has been to determine, by means of thorough analyses, which metals are actually available in a high state of purity, and to promote the manufacture of batches of higher-purity material where this has been necessary On the advice of the Committee, the Department has acquired limited quantities of some of these latter metals, and others are being obtained The Department also has a considerable amount of information about these elements which will be published more fully in the near future On the basis of this, the following classification into groups has been made (1) metals available commercially in a purity approaching

99 99 per cent (information can be given as to where they can be obtained), (2) metals of high purity, not generally available, which have been produced for the Department and can be supplied for research purposes, (3) metals not yet available in a pure state but which are being produced for the Department, (4) metals which do not appear to be of sufficient interest to justify action at the present time All inquiries regarding this work, including information regarding metals in group 1 and the conditions under which metals in group 2 can be made available to research workers, should be addressed to the secretary of the D S I R Pure Metals Committee, Metallurgy Division, National Physical Laboratory, Teddington, Middlesex

## Natural History on Stamps

AN article in a recent issue of the *Australian Museum Magazine* (10, No 1, December 31, 1949) describes an attractive exhibit which has been prepared in the Museum In view of the increasing interest in the collecting of stamps according to the subjects or scenes shown thereon, the Museum has installed a display of 192 sheets showing mammals, birds, fishes and other animals The display was presented by Mr J Whitsed Dovey, of Roseville, Sydney, and covers a representative selection of his collection of fifteen thousand zoological stamps About 250 different zoological subjects have appeared on the postage stamps of all countries, and the modern tendency to add variety to stamp designs by depicting some of the fauna of the country concerned is illustrated by the current Australian stamps showing a kangaroo, an emu, a kookaburra, a platypus, a lyre bird and a crocodile, besides a merino ram and a Hereford bull, representative of Australian pastoral and grazing industries Previous Australian issues have featured other subjects, such as a swan, a horse and a dove In all these cases the zoological subject has been the main feature of the design The display in the Museum was made up of two thousand stamps and was accompanied by scientific descriptions prepared by members of the Museum staff

## Taxonomy of Tropical African Plants

A MEETING, attended by twenty-one botanists interested in the flora of tropical Africa and representing six different institutions, was held in the Herbarium of the Royal Botanic Gardens, Kew, on September 15, with Dr W B Turrill, keeper of the Herbarium and Library, in the chair It was unanimously decided to form an association of botanists interested in the taxonomy of tropical African plants, with the view of increasing international collaboration among such botanists, and of correlating the taxonomy and nomenclature in regional floras (Angola, Belgian Congo, Tropical East Africa, etc ) now in preparation Dr J Léonard, of l'Institut National pour l'Étude Agronomique du Congo Belge, 236 Rue Royale, Brussels, was elected secretary A fuller account of the meeting, and of the aims of the new association, will be published in the *Bulletin de la Société Royale de Botanique de Belgique* early next year Meanwhile any information regarding the association can be obtained from the secretary

## *Focus* A Geographical Study of Modern Events

A FOUR-PAGE leaflet entitled *Focus* is published by the American Geographical Society (1 dollar per ten issues) It is to appear monthly except in July and August *Focus* aims at providing a geographical background to the major events in the world Physical features, land use, communications, mineral and power resources play an important part in political events and are too often overlooked The first number deals entirely with Korea and gives a brief summary of the country's features and resources, with special insistence on the country's unity and the unsuitability of the parallel of 38° N as a political barrier A number of maps show that the products of North and South Korea are complementary The North needs rice and barley from the South and produces coal, iron and power; but the bulk of the population lies in the South and that, too, is the part with the most extensive plains From time to time map supplements will be issued with *Focus* The first of these is a map of the world on a scale of 1 30,000,000 Future subjects will be the oil resources of the U S S R, water problems in the United States and the strategic position of Iran

## *Bulletin of the Raffles Museum*

THE Second World War and subsequent banditry have caused a long interruption in anthropological work in Malaya, and the disturbance to aboriginal life which they have brought about has rendered it more urgent if much information is not to be lost for ever The appearance of the *Bulletin of the Raffles Museum* (Series B, No 4, December 1949, Singapore Malayan Government, 4*s* 8*d* ), the first since the War, is therefore most timely It includes an article on air photography by P D R Williams-Hunt, an aboriginal word-list and a number of notes and short articles by H D Collings, and a contribution by H D Noone, whose death during the Japanese occupation was a grievous loss to anthropology It is to be hoped that circumstances will now allow the *Bulletin* to appear regularly

## A Study of Drying

THE Institute of Fuel has decided to make "A Study of Drying" during the 1950–51 session, and for this purpose a committee of thirteen, with T C Bailey as chairman, has recently been formed The aims of the Study are threefold the fundamental principles of the drying of materials and the main features of drying practice, with emphasis on over thermal efficiency, new methods and techniques, assessment of the limitations of existing knowledge and consideration of new fields to explore The removal of water by filtration, pressing, centrifuging, crystallization or sedimentation falls outside the scope of this investigation The Study will consist of the presentation of a number of papers, followed by discussion, and the first three papers will be given on December 5 at 5 30 p m at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1 (admission free) The subjects and speakers are "Some Fundamental Aspects of Air-Drying of Solids", by R Hendry and Dr A W Scott, "The Determination of Moisture in Coal", by E G Barber, and "Methods of Estimating Moisture", by A H Ward Further papers will be given later in various regions of Great Britain, and the Study will conclude with a conference in London The whole programme has been arranged under the following headings fundamentals of drying, drying in the textile, paper and allied industries, drying in the clay industry, drying of pastes, powders and crystals, drying of fuels, sand, etc, drying in agriculture and forestry, and drying of animal by-products and miscellaneous substances Members of the Institute and others are invited to submit short papers or articles setting out experiences and problems (where possible, with answers) so that the Study may be made as fully representative as possible of all points of view Such papers and all inquiries should be addressed to the secretary of the Institute of Fuel, 18 Devonshire Street, Portland Place, London, W 1

## Iron and Steel Institute Awards

THE Bessemer Medal for 1951 of the Iron and Steel Institute has been awarded to Mr Ben Fairless, president of the United States Steel Corporation, in recognition of his distinguished services to the iron and steel industry The Sir Robert Hadfield Medal for 1951 of the Institute has been awarded to Mr William Bair, of Colvilles, Ltd, president of the West of Scotland Iron and Steel Institute, for his contributions to research in steelmaking Dr C H Desch has been nominated for honorary membership of the Iron and Steel Institute

## Institution of Mining Engineers

SIR ANDREW BRYAN has been re-elected president of the Institution of Mining Engineers for the year 1951–52 The Institution has announced the award of the following Medals *Institution Medal:* this, the highest distinction the Institution can bestow, has been awarded to M Etienne Audibert, president, Charbonnages de France, and director-general, Centre d'Etudes et Recherches, in recognition of his distinguished services to mining engineering and of his achievements in research into safety in coal mines. *Douglas Hay Medal:* the first award of this Medal, founded in 1950 to perpetuate the memory of the late Prof Douglas Hay, past-president of the Institution, has been made to Prof J Ivon Graham, professor of coal-mining, University of Otago, Dunedin, New Zealand, in recognition of his outstanding contributions to the *Transactions* over a period of many years with particular reference to his work for the improvement of the health and welfare of miners The Institution has also awarded the following Prizes '*Mavor and Coulson*" *Students Prizes*. 20 guineas to K Z George, and 5 guineas each to C R Lloyd Jones and E J Polak, "*Victor*" *Students Prize* of £100 to H S Alpan, *Laurence Holland Prize* of £15 to N E Roberts The fifty-seventh annual general meeting of the Institution will be held at the Connaught Rooms, Great Queen Street, London, W C 2 on January 18, 1951 The summer meeting will be held in Nottingham during July 4–6, 1951

## Conference of the Universities of Great Britain and Northern Ireland

THE 1950 Home Universities Conference, convened by the Committee of Vice-Chancellors and Principals, will be held in the Beveridge Hall, University of London Senate House, during December 15–16 This Conference is open only to delegates appointed by the universities and to specially invited guests The programme consists of three sessions December 15, at 2 30 p m, "The University as a Regional Focus" (chairman, Sir Hector Hetherington), December 16, at 10 30 a m, "National Service and the Universities" (chairman, Mr Avery Woodward), and December 16, at 2 30 p m, "Overseas Students in British Universities" (chairman, Dr Lillian M Penson) For the first session, the opening speakers and their subjects will be Prof W Fisher Cassie (Newcastle upon Tyne), on applied science, Prof T S Simey (Liverpool), on social sciences, Sir Lionel Whitby (Cambridge), on medicine, and Prof Ross D Waller (Manchester), on adult education For the second session, the speakers are Mr C E Escritt (Oxford) and Mr T R Henn (Cambridge) For the third session, the speakers are Dr G V Allen (Malaya) and Sir Ronald Adam (British Council) A full programme is being prepared by the Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1

## Announcements

OWING to illness, Sir James Chadwick will not be able to deliver the Rutherford Lecture of the Physical Society at Cambridge on December 8, and instead the Lecture will be given by Dr A S Russell, of Christ Church, Oxford The rest of the programme for the Society's Autumn Meeting at Cambridge, on "Recent Techniques in the Detection of Elementary Particles", will be held during December 8–9, as planned

THE Pittsburgh Award of the American Chemical Society for 1950, a bronze plaque which is awarded annually for outstanding service to chemistry, has been made to Dr William A Hamor, assistant director of the Mellon Institute Dr Hamor is well known for his management of research projects and as author and editor of numerous scientific publications, including his editorship since 1947 of Chemical Monographs for the American Chemical Society

THE University of Sheffield has conferred the title of emeritus professor on Prof J H Andrew on his retirement from the chair of metallurgy (see *Nature*, July 29, p 174) Dr G B Walker has been appointed lecturer in electrical engineering in the University

THE following appointments in the University of Birmingham have recently been announced *Lectureships*, Dr J Kolbuszewski and I T S Essery (civil engineering), and D V Wilson (industrial metallurgy), *Fellowships*, W A Pullman (James Watt fellow in mechanical engineering), Dr G E Brown and H E Paneth (research fellows in mathematical physics), J J Pick (research fellow in industrial metallurgy) and G K Williamson (research fellow in metallurgy) Messrs Joseph Lucas and Co, Ltd, has covenanted to give £1,800 a year for seven years for the endowment of a fellowship in electro-metallurgy

THE third Anglo-American Aeronautical Conference, convened jointly by the Royal Aeronautical Society and the Institute of the Aeronautical Sciences (of the United States) will be held in Brighton during September 1951 The technical sessions will be held during September 7–11 and will be followed by a number of visits to aeronautical firms and establishments Information can be obtained from the Royal Aeronautical Society, 4 Hamilton Place, London, W 1

*Mathematical Pie* was started by the Gateway School, Leicester, as a wall newspaper dealing with various mathematical topics, and is now being published for general circulation It is hoped that schools and other interested persons will co-operate by sending items of interest so that it can be enlarged and published regularly as a forum of mathematical affairs Copies are available (1*d* for No 1, 2*d* for the next issue) from R H Collins at the Gateway School, Leicester

# THE ANKARA MÉLANGE AND THE ANATOLIAN THRUST

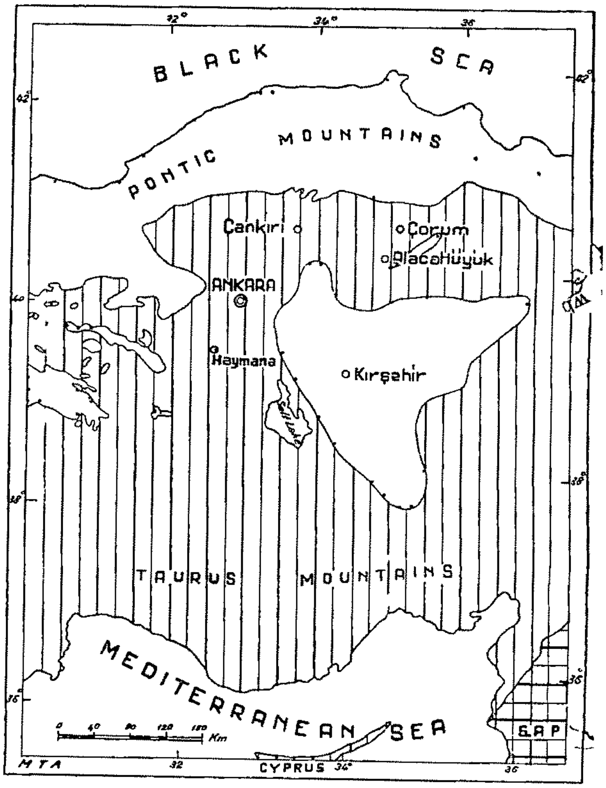
By Sir EDWARD BAILEY, F R.S , and Prof W J McCALLIEN

ONE of us (W J M ) was professor of geology in the University of Ankara from 1944 until 1949 During this period opportunities were taken of exploring many parts of Turkey Welcome financial assistance was received from the Royal Society through the British Council , and invaluable geological guidance was obtained from the findings of previous workers (for example, Chaput[1]) Fortunately, a very useful summary of these findings is available in the eight sheets of the Turkish Geological Survey of the country, 1 800,000, issued during 1941–46 by the Maden Tetkik ve Arama Enstitusu (Institute of Mining Study and Research), which corresponds roughly with the Department of Scientific and Industrial Research in Britain

One result has already appeared, namely, an announcement of the widespread occurrence of pillow lavas[2] Apparently the name pillow lava has not previously been employed for Turkish examples, though some of them are among the clearest in the world In many cases these lavas occur with serpentine and radiolarian cherts in what is known as the green-rock or ophiolite association Thus the recognition of pillow lavas completes for Turkey the Steinmann trinity—pillow lava, serpentine, radiolarite Steinmann's realization of this trinity as a world-wide, age-long characteristic of geosynclinal deposition ranks among the most exciting achievements of geological research (cf ref 3, p 1718) The pillow lavas of Turkey are decomposed basic rocks, of the general type called spilite by Flett and others in Britain Another feature of Turkish geology, well illustrated in the Ankara district along with Steinmann's trinity, is the broken, block condition of pre-Tertiary rocks, holding as a general feature over an extremely wide area The resultant complication is so great that it was decided, if possible, to arrange a joint excursion to investigate the phenomenon in considerable detail The adventure has materialized through the support of the Carnegie Trust, the University College of the Gold Coast, and the Maden Tetkik ve Arama Enstitusu Our work was much facilitated by our enrolment as temporary members of the Turkish Geological Survey

We worked for rather more than a month from two centres, the modern Turkish capital, Ankara, and the ancient Hittite site, Alaca Hoyuk, excavated by the Turkish Historical Society since 1935 Alaca Hoyuk lies a dozen kilometres west-north-west of the town of Alaca and 160 km east-north-east of Ankara Our facilities included 'jeep' transport, which enabled us to wander everywhere The broken rocks, consisting mainly of greywackes, limestones and the Steinmann trinity, are in great disarray , yet, with the help of fossils, mostly of the micro order, and found quite commonly both in the limestones and the cherts, the Geological Survey map has diagrammatically divided the area into Palæozoic and Mesozoic, with local refinements such as Permo-Carboniferous, Lias, Oolite and Jurasso-Cretaceous We established undoubted, important recurrences of rock types at more than one horizon , but broadly speaking, we are satisfied that the main greywackes are Devonian, the main limestones Permo-Carboniferous in an inclusive sense, and the main developments of Steinmann's trinity, Mesozoic It had been impossible for one of us (W J McC ) to undertake detailed mapping while at the University of Ankara, since, quite properly under existing conditions, a foreigner attempting such a task is subjected to endless questioning On the other hand, a research student, Oğuz Erol, starting in 1947 and working under close supervision, has produced a valuable thesis the title of which when translated reads "A Study of the Geology and Geomorphology of the Region S E of Ankara in Elma Dağ and its Surroundings" , and this is illustrated with a careful geological map (not as yet published) on the scale of 1 100,000 For our present purpose it is only necessary to say that Erol firmly established a broken, block structure for the greywacke–limestone complex of the wide district he described, in many cases separating individual blocks of limestone on his map , and that he found numerous microfossils in limestones, some of which have been referred by palæontologists to the Middle Permian We had the great advantage of Erol's company and guidance during one week of our visit

It is thought that it may be helpful to furnish a preliminary note on our results, as they bear closely upon current discussions of such topics as the Simme



First sketch of Anatolian thrust separating Pontic and Taurus rocks, stripped of Tertiary and Quaternary cover S A P = Syro-Arabian Platform

Nappe of the Alps, the Ligurian Nappe of the Apennines, and the Radiolarite Nappe of the Zagros Mountains in Iran.

(1) Ankara is situated upon exposures of pre-Tertiary rocks obscured to some extent by Neogene cover. These exposures, rimmed by Eocene or Oligocene, are due to what may be called the Ankara Anticlinal, and run in a general north-easterly direction, continuing thus to the foot of the Pontic (Black Sea) Mountains past Çankırı, the latter 100 km north-east of the capital. Our personal knowledge of the exposures extends from near Haymana, 60 km south-west of Ankara, to about half-way between Ankara and Çankırı. The width of the belt at Ankara is about 60 km. In all parts of this anticlinal country which we have seen, the pre-Tertiary rocks are in the condition of a mélange, with the possible exception of some of the greywacke, which, however, only gives poor exposures. We know definitely, from our own experience, of some 6,000 sq. km of mélange as exposed along the Ankara anticlinal, and it is clear that this is only a small fraction of an immense whole. For example, Blumenthal[4] in a map showing part of the pre-Tertiary beyond Çankırı reserves a tablet for "Mésozoïque à faciès tectonique brouillé" (see also under heading 4 below). We propose to call this broken mixed zone the Ankara mélange, out of respect for the descriptions that E. Greenly and C. A. Matley have given of the somewhat similar Gwna mélange in Anglesey and the adjoining Lleyn peninsula of Wales[5].

(2) The Ankara mélange is composed of fragments and masses of the component rocks already cited, ranging exceptionally up to kilometres in length. The most widespread and conspicuous blocks are made of white-weathering limestone, bare of soil. Search invariably shows debris of associated rock, greywacke or spilite as the case may be, as soon as one steps off a bare limestone patch, no matter how bizarre its outline. Moreover, numerous exposures of sheared contacts and of discordant dips show that the blocks are tectonic. Some, of course, are composite, consisting, for example, of limestones with accompanying interbedded spilites. The block fragmentation of the Steinmann trinity is also self-evident wherever soil has been washed away. It is advertised by sharp colour and structural contrasts among the component rocks.

(3) The general elongation of component blocks throughout the Ankara mélange tends to be north-easterly. Though contacts are greatly sheared, the interiors of limestone blocks are often massive and there are numerous exposures of undeformed pillow lavas. Where shearing and folding are prominent a crude cleavage is general. The greywackes and accompanying shales are much more broken down and sheared than the limestones.

(4) A group of anticlinal outcrops centred about Alaca Hoyuk shows the Ankara mélange reappearing from under the Eocene. They leave no doubt that the Ankara mélange continues without change of style, not only eastwards as far as Alaca Hoyuk, but also far beyond this ancient site and modern village.

(5) Although the breaking and mixing of the components of the mélange are wonderful to behold, it is evident that it is not complete, since there is a marked tendency for certain types of rock to maintain an irregular association. For example, large areas, predominantly formed of the Steinmann trinity, have been picked out, more or less faithfully, on existent maps. As these areas generally adjoin the Eocene cover, it is certain that at the time of its formation the upper portion of the mélange was formed from what was previously the upper portion of the affected stratigraphical column.

(6) The mélange in places assumes an appearance of *schuppen struktur*, but not with sufficient regularity to warrant deductions regarding the direction of the movement responsible for its production.

(7) Eocene conglomerate-breccias rest on the mélange and present a patent contrast between submarine and subterranean accumulation. The Eocene has derived much of its material from the mélange, including occasional limestone blocks measuring tens of metres, and obviously distributed by tunamis.

(8) The Eocene is sharply folded with dips ranging to vertical, and this adds to the difficulty of interpreting the attitude of blocks contained in the mélange.

(9) Among the serpentines and radiolarites of the Steinmann trinity, we found in five independent exposures variations of the following succession: serpentine; some few metres of calcitized serpentine veined by rather crystalline sedimentary-looking limestone; a small thickness of the same limestone, well bedded; thick radiolarian cherts. These left us in no doubt that many of the serpentines of Turkey are submarine lava flows. Such a conclusion would probably have been reached long ago in this or other regions, if it had not been for the large size of the original olivine crystals, a size that proclaims plutonic growth. Fortunately, N. L. Bowen, as was emphasized at a recent meeting of the Geological Society when he received the Wollaston Medal, has argued on laboratory and field experience that the great bulk of the crystallization of peridotites, from which serpentines have been derived, was completed before the crystal-concentrate plus lubricant-liquid undertook its last journey.

(10) Obviously the radiolaria of the Steinmann trinity have fed on silica-water, supplied not only by submarine, pillow, spilite lavas, as Dewey and Flett have so well maintained[6], but also by submarine, peridotite flows.

(11) There are features of the Steinmann trinity, such as a frequent association of interbedded fine-grained greywacke, which suggest that Steinmann was wrong in assuming great depth of sea at the time of its formation. On the other hand, until peridotite or serpentine lavas are found among terrestrial accumulations, it is plausible to argue that considerable external hydrostatic pressure is required to maintain the lubricant necessary for their outpouring.

(12) We have mentioned under heading (4) how the Ankara mélange, exposed in the Ankara anticlinal, reappears eastwards in the Alaca Hoyuk group of anticlinals. The width of separating Early Tertiary outcrop occupying the intervening synclinal is, in this traverse, 60 km. The synclinal outcrop diminishes greatly northwards past Çankırı, but it increases correspondingly southwards and eastwards past Kırşehir, after which the synclinal may be named.

(13) A remarkable feature of the Kırşehir synclinal is that its Early Tertiary outcrop is in very many places interrupted by great spreads of marble and crystalline schists intruded by granite or diorite. These rocks are clearly pre-Tertiary: they pass under the adjoining Tertiary and have yielded debris to the same. Similar rocks are found occasionally in direct contact with the assemblage characteristic of the

Ankara mélange We shall speak of these crystallines as the Kırşehir crystallines

(14) The highly accentuated synclinal disposition of the Kırşehir crystallines with reference to the Ankara mélange shows that the former constitute part of a great *nappe de recouvrement* covering the latter In the anticlinal areas the Early Tertiaries rest preferentially on the mélange, because the anticlines originated with concomitant erosion before the Early Tertiaries started to accumulate In the synclinal areas the Early Tertiaries rest preferentially on the Kırşehir crystallines, because here erosion has spared extensive masses of the *nappe de recouvrement*

(15) We believe that the Kırşehir nappe is most probably a Pontine nappe, and that the thrust at its base, which we suggest be called the 'Anatolian thrust', is essentially a boundary between Pontic (Black Sea) and Taurus (Mediterranean) pre-Tertiary rocks, which differ in facies The Ankara mélange we interpret as Taurus rocks beneath the Anatolian thrust, the Taurus Mountains as a continuation of similar rocks bulldozed towards the south

(16) The horizontal displacement postulated along the Anatolian thrust amounts to about 350 km This is greater than the minimum displacement measured along other thrusts as yet described The Tornebohm thrust in Scandinavia has a minimum displacement of about 130 km

(17) We are conscious that our conclusions differ considerably from Kober's conception[7] of a *Zwischengebirge* between the Pontic and Taurus Mountains, and also from Paréjas's interpretation[8] of transversal anticlinals and synclinals in the same region

In conclusion, we wish to express our thanks to Prof H N Pamir, director-general of Maden Tetkik ve Arama Enstitusu, and Dr Recep Egemen, director of the Geological Branch of the same, for their constant help during our sojourn in Turkey

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# OXIDATION OF PYRUVIC-OXIME BY SOIL ORGANISMS

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It has been shown by Lees and Quastel[1] that pyruvic-oxime undergoes rapid nitrification in soil during perfusion, and by Quastel and Scholefield[2] that this process is accomplished by organisms other than the autotrophs *Nitrosomonas* and *Nitrobacter* This was proved by the facts that soils enriched with organisms capable of oxidizing pyruvic-oxime cannot oxidize ammonium ions, and that soils enriched with ammonia- or nitrite-oxidizing organisms cannot oxidize pyruvic-oxime (without a preliminary lag period), though they can immediately oxidize ammonium or nitrite ions respectively Moreover, ethyl urethane and methionine, which strongly inhibit the process of nitrification in soil, have no inhibitory effects on the oxidation of pyruvic-oxime to nitrite Potassium chlorate, which retards the development of *Nitrobacter*, is similarly inert Quastel and Scholefield[2] came to the conclusion that soils contain organisms, presumably heterotrophs, that can bring about a speedy oxidation of pyruvic-oxime to nitrite.

This conclusion has now been confirmed, and the present communication represents a preliminary statement concerning the isolation and properties of the organisms concerned

## Isolation of Pyruvic-Oxime Oxidizing Organisms

Soil is perfused at 21° C with pyruvic-oxime solution ($M/200$), neutralized with sodium hydroxide to $p$H 7 2, using the technique of Lees and Quastel[3] as modified by Audus[4], until the oxime is nitrified as completely as possible The soil is washed with water and reperfused with fresh pyruvic-oxime solution until nitrification has again taken place The process is repeated several times until the rate of nitrification has become constant The soil, thus enriched with pyruvic-oxime oxidizing organisms, is removed from the perfusion apparatus after being allowed to drain as fully as possible About 2 gm of the moist perfused soil crumbs are brought into a finely particulate suspension in 6 ml of distilled water by gently grinding in a mortar, larger soil particles are allowed to settle, and the supernatant fluid containing a suspension of fine particles is cultured. The culture medium, containing pyruvic-oxime as the sole source of assimilable carbon and nitrogen, is prepared from the following constituents $K_2HPO_4$, 0 5 gm , $MgSO_4$ $7H_2O$, 0 2 gm. , NaCl, 0 2 gm , $MnSO_4$ $4H_2O$, trace , $FeCl_3$ $6H_2O$, trace , granular agar ('Difco'), 15 gm These are dissolved in 1 litre water, the $p$H adjusted to 7 0, and the solution is dispensed in 100-ml lots and autoclaved at 120° C for 20 minutes 10 ml of a 0 25 $M$ pyruvic-oxime solution ($p$H 7 2), sterilized by Seitz filtration, is added to each 100-ml lot of molten agar, and plates are poured A[illegible] inoculum of 0 1 ml of the soil suspension is spread over each plate, which is incubated either at 25° C or at 37° C.

Discrete colonies are usually obtained, and in spite of the fact that perfusion of the soil has been carried out at 21° C , optimal growth on the plates occurs at 37° C There is no selective effect of incubation temperature, plates incubated at 25° C and 37° C showing the same flora Plates are incubated for 72 hours Nitrite formation by the colonies on the plate is shown by removing a small square (0 5 sq cm ) of the agar bearing the colony and dropping it into a test tube containing Ilosva's reagent A strong positive reaction develops with all colonies of pyruvic-oxime oxidizing organisms Control squares of sterile pyruvic-oxime agar incubated for the same period of time show no trace of nitrite

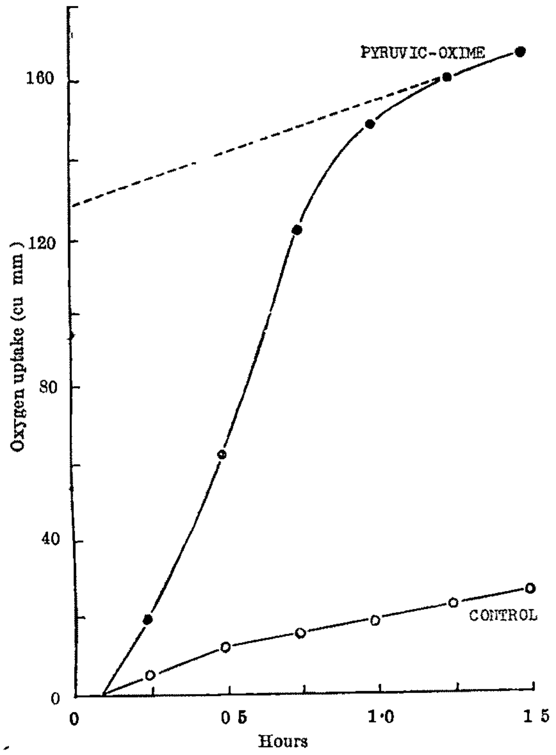
Three distinct species of organisms have been isolated from the plates after subculture from the soil, and all are capable of oxidizing pyruvic-oxime with the formation of nitrite Various organisms will grow on a pyruvic-oxime medium without nitrite liberation, but these organisms are not to be found on plates subcultured from soils enriched, by perfusion, with pyruvic-oxime oxidizing organisms This suggests a process of selection or adaptation during the process of perfusion

Two of the species isolated from the perfused soil fall into the genus *Achromobacter*, the third is identified as a *Corynebacterium* A third species of the genus *Achromobacter* capable of oxidizing pyruvic-oxime to nitrite has been isolated from a sample of fæces

None of a variety of species of micro-organisms held in stock possesses, initially, the power of oxidizing pyruvic-oxime to nitrite, indeed, many of the organisms fail to develop on the pyruvic-oxime medium Growth, when it occurs, is sparse, taking three days to a week of incubation As adaptation is a very likely factor in determining the ability of the organism to attack pyruvic-oxime, four selected species, namely, *Achromobacter hartlebii, Achromobacter perolens, Agrobacterium radiobacter* and *Bacterium globiforme*, have been carried through six successive transfers on pyruvic-oxime agar On the sixth transfer the two species of *Achromobacter* produce small amounts of nitrite *Agrobacterium radiobacter* and *Bacterium globiforme* fail to produce nitrite It is of interest to note that the two species that gain, presumably by adaptation, the ability to attack the substrate with formation of nitrite are both members of the same genus as the two highly active species isolated from the perfused soil

## Pyruvic-Oxime Oxidase

One of the species of *Achromobacter* isolated from the perfused enriched soil is grown on pyruvic-oxime agar plates for 72 hours, harvested and washed with water. The suspension of resting organisms is found to be capable of vigorous oxidation of pyruvic-oxime with liberation of nitrite The enzyme accomplishing this process is termed, provisionally, pyruvic-oxime oxidase



Oxidation of pyruvic-oxime (*M*/750) by isolated *Achromobacter*

The conventional Warburg manometric technique is used for studying the metabolism of the pyruvic-oxime oxidizing organisms and the rates of oxidation of the oxime in presence of these cells For experiment, an appropriate quantity of the washed cell suspension is placed in a Warburg manometer vessel in presence of 0 2 ml 0 02 *M* pyruvic-oxime (*p*H 7 2), the total volume in the flask being made up to 3 2 ml with water The rate of oxygen consumption at 37° C is followed Control experiments are carried out in absence of the oxime Typical curves showing the rates of oxygen consumption are given in the accompanying graph Experiments are continued until the rate of oxygen consumption in presence of pyruvic-oxime, which is initially high, falls to the value obtained by the control in absence of pyruvic-oxime Nitrite formation is estimated colorimetrically, a typical result being shown in Table 1

Table 1 OXIDATION OF PYRUVIC-OXIME BY RESTING CELLS OF THE ISOLATED *Achromobacter*

| Pyruvic-oxime added | Nitrite formed | $O_2$ consumed (corrected for control) | Ratio $\frac{\text{Moles } O_2 \text{ uptake}}{\text{Moles } NO_2 \text{ formed}}$ |
|---|---|---|---|
| 0 2 ml<br>0 02 *M* | 0 16 ml<br>0 02 *M* | 128 c mm | $\frac{128}{71\ 7} = 1\ 78$ |

= 71 7 c mm gas
(1 gm mole ≡ 22 4 l gas)

Nitrite formation, after metabolism of the pyruvic-oxime has ceased, accounts for 80 per cent of the nitrogen added initially as the oxime The oxygen uptake, after correction for the control, is such that the ratio of moles oxygen consumed divided by the moles of nitrite formed is 1 78 The theoretical value of the ratio for oxidation of 1 mole pyruvic-oxime to 1 mole nitrite is 1 This ratio, however, must be increased as further oxidation of pyruvate, formed as an intermediate, takes place Pyruvate alone is oxidized by the species of *Achromobacter* under investigation, at a fairly rapid rate, sufficient to account for the fact that no pyruvate may be detected during the oxidation of pyruvic-oxime Further details of the oxidizing powers of these *Achromobacter* will be published in due course It is considered that the first step in the oxidative metabolism of pyruvic-oxime is according to the equation

$$CH_3\,C(NOH)COOH + O_2 = CH_3CO.COOH + HNO_2,$$

the process being catalysed by the enzyme pyruvic-oxime oxidase

Oxidation of the oxime by the *Achromobacter* is poisoned by cyanide and azide

## Inhibition of Pyruvic-Oxime Oxidase by Oximes

Among the many oximes investigated only pyruvic-oxime and oxalacetic-oxime are oxidized to nitrite on perfusion through soil[2]

A number of oximes are capable of inhibiting, however, pyruvic-oxime oxidase, showing an affinity for the enzyme although oxidation does not take place Three such oximes are phenyl pyruvic-oxime, D-arabinose-oxime, α-ketoglutaric-oxime Typical results are shown in Table 2

Table 2 INHIBITIONS EFFECTED BY OXIMES OF PYRUVIC-OXIME OXIDASE IN PRESENCE OF THE RESTING CELLS OF THE *Achromobacter*

| Oxime (*M*/750) | Percentage inhibition of activity of pyruvic-oxime oxidase Initial concentration of pyruvic-oxime is *M*/750, in presence of phosphate buffer (*M*/30) at *p*H 7 4 |
|---|---|
| Phenyl pyruvic oxime | 33 |
| D-arabinose-oxime | 46 |
| α-ketoglutaric oxime | 32 |

The oximes investigated do not diminish the final values of oxygen consumed or of nitrite produced from pyruvic-oxime by washed suspensions of *Achromobacter* They only retard the rates at which these values are attained They appear to act as competitive inhibitors

## Summary

Three species of organisms have been isolated from a soil, perfused with neutral pyruvic-oxime solution, that attack this oxime with formation of nitrite Two of the species fall into the genus *Achromobacter*, the third is identified as a *Corynebacterium* The enzyme oxidizing the oxime is termed pyruvic-oxime oxidase This may be an adaptive enzyme as it is developed in certain members of *Achromobacter* by continued subculture on pyruvic-oxime media The ratio of moles of oxygen consumed to moles of nitrite formed by resting cells of the isolated *Achromobacter* at 37° C at *p*H 7 4 in presence of pyruvic-oxime is 1 78 Pyruvic-oxime oxidase is inhibited, probably competitively, by phenylpyruvic-oxime, D-arabinose-oxime, and α-ketoglutaric-oxime, which are not themselves oxidized by the enzyme

Grateful acknowledgment is made to the National Cancer Institute of Canada for a grant in aid of a programme of work, of which the above represents a part, and also to Dr S B Baker for the preparation of D-arabinose-oxime

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# AUTOMATIC COMPUTING

A SUMMER school in programme design for an automatic digital computing machine was held at Cambridge in the University Mathematical Laboratory during September 12–21 The arrangements were made with the co-operation of the Board of Extra-Mural Studies, and the lectures and demonstrations were given by members of the staff of the Laboratory and others closely associated with it The course was concerned mainly with the methods which have been developed for use with the EDSAC (electronic delay storage automatic calculator) which has been constructed in the Laboratory The same principles are, however, applicable with small modification to other machines of similar type, and lectures were given by Dr T Kilburn, of the University of Manchester, and Mr J H Wilkinson, of the National Physical Laboratory, on the preparation of programmes for the machines with which they are associated About forty students from universities, industrial research laboratories, and government departments, including several from France, Holland and Germany, attended the course Practical work in numerical analysis and in programme design was included, and there were opportunities for gaining experience in the use of the EDSAC Several members of the course were able successfully to run small problems of their own on the machine

An automatic computing machine can perform a very limited variety of numerical operations—in the case of the EDSAC, addition, subtraction and multiplication only Each operation is called for by an 'order', and to perform even the simplest mathematical calculation an extended sequence of orders is required The sequence of orders is known as the programme The EDSAC uses punched teleprinter tape for input of orders and numbers

In order to simplify the preparation of programmes, it is very desirable that a library of sub-routines, that is, standard sequences of orders for carrying out common arithmetical operations, should be established Sub-routines should be so designed that their incorporation in a programme is as simple as possible At present the library associated with the EDSAC contains about seventy-five sub-routines which fall into various classes There are basic sub-routines for performing the operation of division (the EDSAC has no built-in divider) and for the input and output of numbers These latter sub-routines convert numbers from the scale of ten to the scale of two which is used within the machine, and vice versa, and some of the output sub-routines, in addition, control the layout of the printed page There are sub-routines for taking square roots and cube roots, for evaluating sines and cosines and other elementary transcendental functions, for the summation of power series with real or complex coefficients, and for direct and inverse interpolation On a higher level of complexity are sub-routines for performing numerical quadrature and for integrating ordinary differential equations In another class there are sub-routines which facilitate the handling of complex numbers, 'floating decimal' sub-routines for use in problems in which the magnitudes of the numbers concerned vary over a wide range, and sub-routines for assisting the programmer to prepare programmes in which complicated counting operations are involved Sub-routines are stored in the form of lengths of punched teleprinter tape and can be copied mechanically on to a programme tape

When faced with a new problem, the programmer must first decide which parts of the calculation can be performed by sub-routines from the library, and which parts will have to be programmed *ab initio* The orders for performing the latter may be contained in a master routine (alternatively called a main programme), which will also contain orders for calling in the sub-routines as required It is sometimes convenient to construct one or more sub-routines specially for the problem in hand, these can be called in by the master routine in the same way as library sub-routines The advantage of this procedure is that it enables the master routine itself to be simplified The various routines and any sequences of numbers which are required for the problem are punched separately on short lengths of tape—the library sub-routines are already in this form—and copied mechanically on to a single input tape for the EDSAC This tape contains everything required to enable the machine to perform the calculations, and, beyond putting it in the tape-reader, no setting-up of the machine is necessary

When drawing up a programme it is very easy to make some blunder which may be trivial in itself, but which will cause the machine either to stop or to print wrong or meaningless symbols Experience has shown that one cannot be sure of detecting all these blunders by inspection One method of detecting them is to make the machine proceed order by order under the control of a push-button and to inspect the contents of the store each time This is, however, very wasteful of machine time, and it is better to use methods in which the information required is printed automatically For example, it is a good practice when first designing a programme to arrange that a code letter is printed every time a sub-routine is called in. If then the machine stops on account of an error, the sequence of code letters printed will help the programmer to localize the error. Later, when the programme has been proved to work satisfactorily, the printing of code letters can be cut out. In a similar way, it is a good idea to begin by including orders in the programme which will print out extra numerical information that can be used for checking purposes. These orders can also be removed when the programme has been shown to work correctly. For more detailed checking there are a number of sub-routines in the library which, when attached to a programme, cause the machine to print (in addition to, or instead of, the numbers specified in the programme) some detailed information which can be analysed afterwards. Thus, the machine may print a letter specifying the type of each order (for example, *A* for add, *S* for subtract, etc.) as it is executed; alternatively, the number in the accumulator register may be printed each time it is cleared.

It frequently saves time in the long run if those sub-routines which have been constructed specially for the problem are tested on the machine before being incorporated in the full programme. The sub-routines from the library, of course, are known to be free from error, and this fact alone would make the use of a library highly desirable, quite apart from other advantages.

Members of the summer school were shown various examples of programmes prepared for the EDSAC, including one for obtaining solutions of Emden's differential equation which occurs in astrophysics. The EDSAC has also been applied to problems arising in geophysics, wave mechanics, statistics, electron optics and electrical engineering.

M. V. WILKES

## SPECIAL LIBRARIES AND INFORMATION SERVICES

THE twenty-fifth annual conference of Aslib, held at the University of Bristol during September 22–25, marked the beginning of the second quarter-century of service of the Association of Special Libraries and Information Bureaux, and was attended by two hundred and thirty delegates representing a wide variety of interests and studies, scientific and humane. The conference was welcomed by the vice-chancellor of the University, Sir Philip Morris, at a dinner and reception on the night of September 22.

At the opening session on the morning of September 23 the president of the Association, Dr. Percy Dunsheath, made a short speech in which he described Aslib as an "invisible investment" paying to the nation dividends both tangible and generous, since it is a society of special libraries—"places where the progress of science and specialized knowledge are fostered and furthered at every step". The usual presidential address was replaced by one by the director, Mr. Leslie Wilson, who paid a warm tribute both to the voluntary effort which has built up the Association in the past and to the generous support received for some years through the Department of Scientific and Industrial Research and now greatly increased. While welcoming the present trend in national life towards a partnership between voluntary effort and State support, he emphasized the obligation on recipients of such support to think in terms of the national and not merely the professional need. The primary duty of Aslib at the present time is to those, particularly in industry, who are called upon to be the leaders in national recovery. The main sinew of their effort is industrial research; it is Aslib's concern that more special libraries and information bureaux should be set up in industry to supply vital scientific and technical information to research departments. The Association hopes to establish more local branches and a number of groups representing the interests of particular professions or trades, expanding by these means not only its membership but also one of its most valuable services—the provision of facilities for the cross-fertilization of ideas. Aslib is well represented on the Nicholson Committee, the successor of the King Panel on Technical Information Services, and is responsible for representing Great Britain (the director hoped with increasing energy) in the field of international documentation. There is still an enormous field for research in special library methods, and Mr. Wilson said that he hopes before long to set up a research committee to carry on this work and publish its results. He could not envisage a single organisation serving effectively both the technical and the professional interests of librarianship—it might be that the latter should rest more particularly on the Library Association—but he felt sure that the fundamental activity of Aslib must in the long run consist of research into the techniques of special librarianship and information work.

On the afternoon of September 23, Mr. F. L. Kent, librarian of the University of Bristol, presented a paper on the library resources of Bristol and the south-west of England. It is hoped that similar surveys of other regions will enable a general view to be arrived at of the resources of Great Britain as a whole, particularly in special and technical libraries which might be willing to co-operate in the national inter-library lending service. The paper was followed by a comprehensive programme of visits to libraries, including the University Library (general and medical libraries, engineering division, and botany and zoology departments), the City Library and the South-Western Regional Library Bureau, and the libraries of the Bristol Aeroplane Co. and the National Smelting Co.—most delegates being able to visit at least two of these. In addition, arrangements were made for individual delegates to see the libraries of the University of Bristol Institute of Education, Southmead Hospital and Messrs. W. D. and H. O. Wills, Ltd.

The third session, on the morning of September 24, consisted of papers by Miss M. Exley and Mr. W. Ashworth on the re-planning and re-organisation of special libraries, the former being concerned mainly with buildings, equipment and administration, and the latter with re-cataloguing and re-classification. At the afternoon meeting, Miss E. Ditmas, former director of Aslib, presented a paper on the literature of special librarianship, containing a select bibliography of three hundred items, copies of which were exhibited in an adjoining room. This paper gave rise to useful discussion on the future publishing programme of Aslib and the possibility of collaboration with the Library Association in this field. The conference concluded with a paper on the Earl of Leicester's Library at Holkham Hall by Dr. W. O. Hassall, who, to at least one member of his audience conveyed once again that sense of the unity underlying all the diversities of librarianship, research and learning which was present throughout the conference.

F. L. KENT

# THERMODYNAMICS OF ADSORPTION

AN informal discussion on "The Application of Thermodynamics and Statistical Mechanics to Adsorption Problems" was held in the Chemistry Department, University College, Dundee (University of St. Andrews), during July 20–21. Twenty-five people were present. With this small group a very close exchange of views was possible, and the discussion throughout was brisk and lively. The discussion was divided into two parts: (1) monolayer adsorption, (2) multilayer adsorption and hysteresis.

The first section was opened by Dr. C. Kemball (Cambridge), who presented a paper on the entropy of adsorption. He showed how a knowledge of entropy changes can throw light on the mobility and lateral interaction of the adsorbed molecules, and how the entropy can be obtained both from experimental data and also theoretically, and stressed the importance of resolving free energies into their respective heat and entropy components. Two cases were dealt with, the mobile and immobile film. Comparing the experimental results with the theoretical, it is found that the results can be divided into four classes: 'supermobile' (xenon on mercury at 260° K.), mobile (ethane on chabazite at 430° K.), intermediate (benzene on mercury at 323° K.) and immobile (hydrogen on glass at 20° K.). Dr. Kemball stressed the need for accurate surface-area determinations.

Prof. D. H. Everett (Dundee) prefaced his paper on the relation between heats and entropies of adsorption with a discussion of the various thermodynamic quantities which have been used to describe adsorption data. The conditions under which these sets of free energies, heats and entropies can be derived from experimental results were precisely specified and the relationships between them indicated. As in the study of solutions, a reference system is desirable. In monolayer adsorption this can be either an ideal localized monolayer or an ideal two-dimensional gas. Using the former model as a reference state, it has been found that the 'excess' partial molar entropy of adsorption, obtained by deducting the estimated configurational entropy from the experimental entropy, is a linear function of the differential heat of adsorption. This line, for twenty adsorbates on charcoal at 0° C., was superposable on the Barclay–Butler heat-entropy plot for the evaporation of liquids. An extension of this method of analysis to low-temperature adsorption results (with Dr. D. M. Young) shows that the characteristics of the heat-entropy plot are markedly influenced by temperature. Prof. Everett concluded that the localized monolayer seems to be a satisfactory reference system, and pointed out the possibilities of a more extensive examination of the heat-entropy relation.

Prof. R. M. Barrer (Aberdeen) and Dr. Kemball both stressed the difficulties encountered in reaching any fundamental conclusions about heat-entropy relations, as the experimentally accessible range of $\Delta G$ values is often rather small compared with the corresponding changes in $\Delta H$ and $\Delta S$.

Dr. H. C. Longuet-Higgins (Manchester) outlined the method by which he is bringing statistical mechanics to bear on the general relation between heats and entropies. The Barclay–Butler rule for the heats and entropies of solution of a gas in a liquid can be simply derived, using Henry's law, if certain additional assumptions equivalent to the Law of Corresponding States are made regarding the nature of the solute-solvent interactions. This treatment has been extended to adsorption assuming a mobile film and Henry's law, and it was shown that here also a linear heat-entropy relation is to be expected.

Dr. G. Szasz (Office of Naval Research, American Embassy, London), speaking on calorimetric measurements of specific heats and entropies of adsorption, presented some recent experimental work from the laboratories of Prof. J. G. Aston (Pennsylvania State College) and Dr. J. A. Morrison (National Research Council, Ottawa). From the results of Aston, Szasz and Kingdon, a calculation has been made of the entropy difference at 0° K. between a film of nitrogen on titanium dioxide corresponding to a completed monolayer, and a film containing 0.6 this amount of nitrogen. They found a positive value (+1.6 ± 1.6 cal. deg.$^{-1}$ mole$^{-1}$) instead of the negative value expected for an ideal localized monolayer. An explanation for this result was suggested by Prof. Barrer, who pointed out that on a heterogeneous surface the entropy calculated by the usual formulæ of statistical mechanics would be in error. Later in the discussion an alternative explanation was suggested by Prof. Everett, who showed that it would be accounted for if, in fact, a second layer had started to form before the completion of the monolayer. Measurements have also been made by Dr. Morrison and Dr. Los of the specific heat at four-tenths coverage, as a function of temperature, for argon on rutile of a high specific surface down to 14° K. Dr. Szasz presented some of their preliminary results, which exhibited a number of interesting features. Detailed discussion of these points seemed unwise until confirmed by later work.

Dr. A. R. Miller (Cambridge) discussed the theoretical calculation of heats of adsorption and showed that the variation of heat with coverage may be caused either by interactions between the adsorbed particles or by surface heterogeneity. He pointed out that no experiments of sufficient accuracy have been published which make it possible at present to distinguish between these two effects. Dr. Miller also mentioned that measured heats of adsorption of polar molecules indicate that existing methods of dealing with long-range interactions between adsorbed molecules are inadequate. He suggested that some recent work on the order–disorder problem could be extended to take account of long-range forces. The ensuing discussion dealt with uniformity and non-uniformity of surfaces. Dr. J. H. Singleton (Aberdeen) directed attention to the striking change in the surface properties of a metal when only a few molecules are chemisorbed on it. Dr. Szasz referred to recent Russian work which indicates that the change of heats with coverage can be accounted for by 'induced heterogeneity' on an initially uniform surface. Mr. A. S. Porter (Imperial College, London) mentioned the experiments of Emmett and Kummer with carbon-14 monoxide and carbon-12 monoxide, which these authors claim demonstrate the effect of heterogeneity.

Dr. D. M. Young (Dundee) showed that recent work with Dr. F. C. Tompkins (Imperial College, London) has confirmed Orr's experimental heats of adsorption on cæsium iodide crystals, but also that Orr's calculations do not refer to the same crystallographic plane as his experiments. Recent experimental work at Dundee shows that the heats of adsorption of argon on potassium chloride are some 500 cal./mole higher on the (111) than on the (100) plane. A possible link between these studies and the theory of crystal growth and habit modification was indicated. Some unpublished work of S. Ross and G. E. Boyd (Oak Ridge) on the low-temperature adsorption of ethane on a number of sodium chloride preparations was mentioned. These results suggest that each step in a step-wise isotherm can be attributed to a different crystallographic plane present on the surface. Dr. Kemball directed attention to some interesting step-wise isotherms for acetone on liquid mercury, where each step appears to denote the filling of a fresh layer. The question of step-wise isotherms was discussed and it was felt that the available experimental results were insufficient to warrant a general interpretation of this phenomenon.

The section on multimolecular adsorption was introduced by Prof. Barrer (Aberdeen). Brief mention was made of the recent statistical derivation (with Dr. R. R. Fergusson (Aberdeen)) of the Hüttig equation; it was pointed out that this equation can also be derived using Hill's method of 'vertical counting'. He considered that the main weakness of the Hüttig and Brunauer–Emmett–Teller (B.E.T.) models is their neglect of interaction forces. A new statistical treatment of adsorption was outlined in which it is assumed that sorption centres initiate the growth of compact clusters of limited size (as distinct from the columnar clusters assumed in B.E.T. or Hüttig treatments). Neglecting lateral interactions between molecules in the cluster, isotherms obtained are type I with some variations. Prof. Barrer and Mr. Robins (Aberdeen) have made considerable progress with another new model which, like Polanyi's treatment, takes into account interactions between sorbed molecules, as well as the comparatively long-range nature of dispersion forces acting between a massive substrate and a gaseous molecule. The adsorbed phase is regarded as a compressed three-dimensional gas. It is assumed that van der Waals' equation of state is valid over the entire range of the adsorption isotherm, and that the interaction energy between a molecule and the surface varies as the inverse cube of the distance. Although no simple relationships emerge, it has been possible, using selected values of the heat of adsorption, to obtain for adsorption on a plane surface isotherms corresponding to the first three types in the B.E.T. classification, all the isotherms reducing to type I at temperatures above the critical temperature of the adsorbate. The theory is also being extended to include adsorption between parallel planes (cracks) and in capillaries, and on this basis it appears possible to obtain the other two general types of isotherm.

Prof. Everett indicated a possible approach to the thermodynamic treatment of multilayer adsorption. If the Barclay–Butler rule be assumed valid over the entire adsorption process, a knowledge of the differential heat of adsorption will permit the interpolation of the excess entropy term from the Barclay–Butler line. A comparison of this term with the experimental entropy would give a measure of the configurational entropy as a function of the amount adsorbed. This treatment has been applied to some results of Crawford and Tompkins; the configurational entropy corresponds closely to that calculated for an ideal localized monolayer up to about half-coverage, after which a sudden inflexion marks the beginning of a steep rise in partial molar configurational entropy. The general shape of the curves obtained by this method correspond to that expected for a localized model, where adsorption in the second layer takes place on sites provided by groups of first-layer molecules. The increase in entropy arises from the increasing number of arrangements possible when adsorbed molecules can also occupy sites in the second layer.

Isotherms for a number of organic vapours on nickel oxide were presented by Mr. G. Schreiner (Cambridge). These have been analysed from a thermodynamic point of view using Dr. Kemball's method, in which values of the entropy are calculated at a standard state corresponding to a definite fraction of the surface covered. The assignment of a definite value of the fractional coverage is only possible if reliable values of the monolayer capacity are available. To this end, a detailed examination of the values obtained from the B.E.T. and the Volmer isotherms has been made. The B.E.T. values are about seven-tenths of the Volmer values, but it was concluded that the latter lead to a more consistent definition of the standard state.

Mr. W. I. Whitton (Dundee) described some isotherms which he has measured for benzene on charcoal over a range of temperatures. At high coverages the adsorption and desorption isotherms are separated by a hysteresis loop, but the marked capillary condensation just as the saturation vapour pressure is reached was found to be completely reversible. The general shape of these isotherms suggests that capillary condensation does not become appreciable until the pressure approaches the saturation vapour pressure. The vigorous discussion of adsorption hysteresis which ensued demonstrated the need for more detailed theoretical and experimental work on this topic.

Prof. W. F. K. Wynne-Jones (Newcastle), Drs. S. J. Gregg (Exeter), P. Meares (Aberdeen), R. C. Pink (Belfast), R. R. Smith (Dundee), and Mr. F. W. Smith (Dundee) also contributed to the discussion.

W. I. WHITTON
D. M. YOUNG

# INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

## ANNUAL REPORT FOR 1949–50

THE annual general meeting of the Indian Association for the Cultivation of Science was held in Calcutta on July 25. The Joy Kissen Mookerjee Gold Medals for 1947 and 1948 were awarded to Mme. Irene Joliot-Curie, director of the Radium Institute, Paris, and to Dr. Arthur E. Morgan, president of the Tennessee Valley Authority, respectively. Sir Robert Robinson, president of the Royal Society, received the Association's Bimala Churn Law Gold Medal for 1945, and the same Medal for 1949 was awarded to Sir Alexander Fleming. Prof. Hermann E. Mark, director of the Polymer Research Institute, United States, delivered a course of lectures as Coochbehar professor of the Association.

The members of the Council of the Association for 1950–51 are as follows: *President*, Prof. M. N. Saha; *Vice-Presidents*, Dr. J. C. Ghosh and Dr. D. M. Bose; *Honorary Director*, Prof. P. Ray; *Ordinary Members*, Dr. S. R. Bose, Sri Dwijesh Chandra Chakravarti, Dr. B. C. Guha, Dr. Satish Chandra Ganguly, Prof. S. K. Mitra, Prof. P. C. Mahanti, Prof. S. K. Ray, Hon. Sri C. C. Biswas, Dr. S. K. Banerji and Dr.

P N Brahmachari, *Trustee-Member*, Hon Justice R P Mookerjee, *Nominees of the National Institute of Sciences of India*, Dr B B Dey and Dr D S Kothari, *Nominees of the Government of India*, the secretary to the Department of Scientific Research, the educational adviser to the Government of India, Sri M S Bhatnagar and the joint finance secretary, *Nominee of the Government of West Bengal*, Dr D M Sen; *Professor-Member*, Prof Santi R Palit

In presenting the annual report of the Association for 1949–50*, the honorary director, Prof P Ray, said that the major construction work of the new research building of the Association at Jadavpur, which was started in March 1949, had been completed by March this year The new Department of Organic Chemistry was opened during the year, and efforts were being made to bring into existence the Department of Theoretical Physics

During 1949–50 the Association received a capital grant of Rs 400,000 from the Government of West Bengal and a loan of Rs 80,000 from the Government of India towards the construction of the new research building The Government of India had previously made available a capital grant of Rs 432,000 and a loan of Rs 500,000 for this purpose The other receipts included a recurring grant of Rs 256,025 and a non-recurring grant of Rs 30,000 for research training facilities, both from the Government of India The Council of Scientific and Industrial Research also financed two research schemes on X-ray investigation on coal and on the construction of osmometers for high-polymer research, for which sums of Rs 9,383 and Rs 2,550 were made available, respectively

The annual report gives an account of the research work of the various Departments In the Department of X-rays and Magnetism, B S Basak investigated the crystalline structure of phenanthrene, B K Banerjee the study of the glass system by X-ray diffraction and other physical methods, and R K Sen continued his work on the extra reflexions in Laue photographs of single crystals of benzil J Sen and B K Banerjee investigated the change in orientation of cellulose in sound and infected tracheids of *chir* by the X-ray diffraction method, S C Mitra the high-temperature behaviour of the crystals of a number of Tutton salts, and A K Dutta thermoelectric phenomena in semi-conductors Investigations in the Department of Optics included work on the origin of low-frequency Raman lines due to organic compounds in the solid state, on the Raman spectra and molecular structure of organic compounds in different states, the excitation of the Raman spectra by the resonance line of mercury, the fluorescence and absorption spectra of diamond crystals and the absorption of ultra high-frequency radio waves by organic liquids

In the Department of Physical Chemistry, fundamental studies on polymerization kinetics continued, and the inhibition and retardation of vinyl polymerization, chain transfer by solvents in vinyl polymerization, the catalytic preparation of silicone resins, the solubility and co-solvency and the dielectric behaviour of metallic soaps were all investigated, but although a programme of work for the Department of Organic Chemistry which was started in September 1949 has been planned, work has been limited to establishing the laboratory and preliminary studies on the technique of chromatography

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* Indian Association for the Cultivation of Science Annual Report for 1949–50 Pp 49 (210 Bowbazar Street, Calcutta 12, 1950)

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# FOREST PRODUCTS RESEARCH

IT is remarkable that it has required two World Wars to bring to the public a realization of the enormous potential value of research work into the products of the forest The Forest Research Institute at Dehra Dun in India was inaugurated in 1907, and, with the encouragement of the late Lord Curzon, at that time Viceroy of India, a building was opened in 1912 which was thought to be of sufficient size for the next twenty years The work undertaken during the first years remained unknown outside the Forest Department itself and a few officials of the Government of India Soon after the outbreak of war in 1914, India discovered that she would have to become self-supporting in a number of articles required by industry and in the household Heavy work at once fell upon the young Research Institute, work which met with such success that at the close of hostilities the Government sanctioned funds for a spacious building, including laboratories and so forth, and a largely increased staff In the Second World War the Institute proved its value to the country, its work and gathered experience enabling problems to be solved of a complexity which only research on a high plane could have made possible

A few years after the close of the First World War, the Forest Products Research Laboratory was opened at Princes Risborough, Aylesbury, Bucks, with a research board under the Department of Scientific and Industrial Research Here again recognition by industry and the public at large came slowly, and once more it required a World War to show the great value of its work Owing to the War the customary annual reports were held up, and the reports for 1939–47 have been recently issued combined under a single cover* The reports are in two parts, the first those of the Forest Products Research Board, and the second of the director of forest products research, Dr F Y Henderson

In a summary of the war activities the director deals briefly, showing the wide range of the research work undertaken, with the following charcoal production in portable kilns, home-grown timbers, corrosion of metals contained in wooden cases, seasoning, rifle furniture (stocks and so forth), wood-bending, timber for aircraft, peeling tests, laminated wood, adhesives, fire resistance and extinction, physics, utilization of wood waste (including sawdust), survey of damage by insects in national stocks of hardwoods, dry-rot in buildings (damaged by air-raids, especially in cases where large quantities of water had been used to extinguish the fires), and advisory work to government departments, big industries and so forth

In an introductory note, the Forest Products Research Board says "One of the most serious impacts of the war upon the timber-using industries was the drastic constriction, or with respect to some species the complete cessation, of supplies of timber, either as raw material or as products". An early problem was to make good the serious loss of supplies of charcoal, to a considerable extent imported from Germany before the War, and which is essential for the rayon, non-ferrous metal and other important industries Those who have visited some of the hardwood forests in the southern parts of England know how the Forest Products Research Laboratory solved this difficulty by its portable charcoal-burning kiln, and it followed up developments and exploitation of this beyond normal limits by seconding one of its officers to the Timber Control Department to supervise the erection and working of the kilns and by training operators The other important subject mentioned is in connexion with plywood and the revision of the aircraft plywood specification, leading to simplification and the conservation of supplies These activities on the part of the Laboratory have brought it into much closer relation to the timber-using industries and made them aware of its value to them

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* Reports of the Forest Products Research Board, with the Reports of the Director of Forest Products Research, for the years 1939–47 Department of Scientific and Industrial Research Pp 94+10 pl (London H M Stationery Office, 1950) 3s 6d

In 1943 the Board commenced to consider recommendations for post-war work of the Laboratory As the director states, the necessity now exists of placing the Laboratory in a good position to meet the increasing requests by industry for advice, to make its results more effectively known, and to expand the resources of the Laboratory both in income and material Detailed accounts of the work carried out in the years 1946 and 1947, together with some interesting illustrations, complete the reports

E P STEBBING

# BIRD MIGRATION IN THE TRENT VALLEY

DURING the autumn months of July, August, September and October in the years 1940–47, continuous observations of the movements of bird migrants were made by R J H Raines along the Trent Valley in Nottinghamshire and on the extensive Nottingham sewage farms These observations revealed that a substantial passage movement of a wide variety of species regularly takes place in the region The facility with which movements are observed in the district is attributed to the narrowness of the valley and the situation of the sewage farms in its course as potential feeding and resting grounds (*British Birds*, 43, 140, 4, April 1950)

A total of 126 species of migrant birds has been recorded from the district during the years under observation Of this number, ninety-three species have occurred regularly, many in extremely large numbers, and the remainder have been recorded as rare vagrants or of irregular occurrence

The migratory movements were of four kinds an exodus of local summer residents, an emigration of summer residents of more distant origin, a passage migration of foreign birds and a local movement of some British resident species The great majority of these movements occur on a south-westerly flight, but a large number of birds, most probably emigrants, move in an easterly direction, several species migrate from east to west

It has been inferred that many migrants reach the Trent Valley by at least two main routes One stream of migration arises on the Yorkshire coast in the region of Flamborough Head, crosses the East Riding to the Humber and then passes up the River Trent to reach the Trent Valley near Newark Some proportion of migrants reaching Spurn Head cross the Humber mouth and probably turn inland on the North Lincolnshire coast, then pass over North Lincolnshire towards Lincoln and Newark, thus reaching the Trent Valley by a direct south-west course.

The two streams of immigrants meet at the mouth of Trent Valley, pass along the Trent through South Nottinghamshire and Derbyshire, leave the Trent and move through the region of Birmingham and South Staffordshire, most probably to the Severn Valley It may be surmised that the passage continues to the south coast of Britain or the Bristol Channel

The most important of the factors affecting inland migration is the direction and velocity of the wind Opposing winds, unless strong, appear to be favourable to the progress of migration, whereas following winds are less favourable to the majority of migrants, though apparently necessary for the local occurrence of some species such as the wood-sandpiper

# SOCIETY OF FORESTERS OF GREAT BRITAIN

## ANNUAL GENERAL MEETING

AT its recent annual general meeting in Oban, the Society of Foresters of Great Britain unanimously awarded the Society's medal to Sir John Stirling Maxwell, in recognition of his pioneer work in planting peat land at Corrour and Fersit, which was the basis of the system now in general use by the Forestry Commission

The following office-bearers and councillors were elected *President*, Prof H M Steven, Department of Forestry, University of Aberdeen, *Vice-President*, A H Gosling, director-general, Forestry Commission, *Editor of Journal*, R W V Palmer (c/o Estate Office, Eastnor, near Ledbury, Herefordshire), *Business Editor*, J A B Macdonald, silviculturist (north), Forestry Commission, *Secretary and Treasurer*, R A Galloway (8 Rutland Square, Edinburgh, 1), *Auditor*, D L Ferguson, Forestry Commission, Edinburgh, *Councillors*, Prof H G Champion, Imperial Forestry Institute, Oxford, Sir Henry Beresford-Peirse, director of forestry for Scotland; W E Hiley, manager, Dartington Woodlands, Ltd, South Devon, G B Ryle, conservator (private woods), Directorate for England, A P Long, director of forestry for Wales, Bruce Urquhart, technical officer, Co-operative Forestry Society (Scotland), Ltd, Edinburgh

The meeting took place during the annual excursion, held this year in Argyll, with headquarters at the Great Western Hotel, Oban, in which about sixty members took part Visits were paid to Inverliever and Barcaldine Forests of the Forestry Commission and to the Argyll Estates at Inveraray and Sir George Campbell's Cumlodden Estate These visits brought out several points of importance the remarkable rate of height growth and volume production particularly of the Pacific coast species, sitka spruce, *Abies grandis* and *Tsuga heterophylla*, the problems of spacing, time of first thinning and degree and interval of thinning arising out of this growth, the problem of extraction under certain conditions in the west, arising out of the broken nature of the ground, the high rainfall and peat conditions

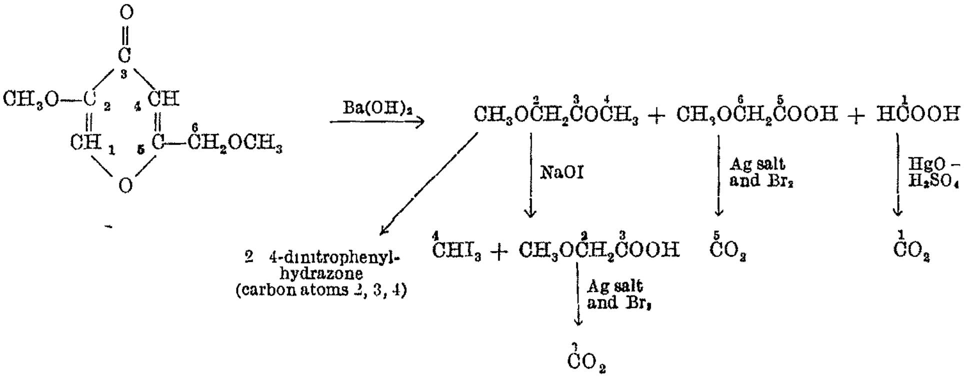
At Barcaldine Forest the members saw a magnificent clump of Douglas firs to which the name of "Sutherland's Grove" was given in recognition of the work of Sir John Sutherland, who was the first assistant commissioner for Scotland under the Forestry Commission and was associated with Barcaldine both before and after its acquisition by the State

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Kojic Acid Biosynthesis from 1-$C^{14}$-Glucose

THE biosynthesis of kojic acid by *Aspergillus oryzæ* has been investigated by growing the mould on Czapek–Dox medium containing 1-$C^{14}$-glucose[1] and 0.1 per cent yeast extract. Surface cultures were grown in 1-litre conical flasks through which air was continuously passed. The radioactive carbon was located by degrading dimethylkojic acid as shown below[2] (the carbon atoms of kojic acid have been numbered from 1 to 6 in order to simplify subsequent comparison with glucose).



When carbon-14 glucose (specific radioactivity $89.3 \times 10^{-3}$ μC/mM) was present from the time of inoculation, the isolated kojic acid had a specific activity of $91.0 \times 10^{-3}$ μC/mM, after sublimation. In this experiment (see table, experiment 1) the kojic acid was diluted with carrier before methylation; a sample of the dimethyl compound (not recrystallized) prepared from undiluted kojic acid had a specific activity of $84.7 \times 10^{-3}$ μC/mM.

On degradation, most of the radioactivity (74 per cent) in this sample was located in carbon atom 1. The remainder of the activity was distributed fairly evenly over all the other carbon atoms. When carbon-14 glucose was added at a later stage (see experiment 2) up to 80 per cent of the radioactivity was located in carbon atom 1.

We are indebted to Dr. J. A. Barltrop for suggesting that the degradation of dimethylkojic acid may proceed through 1 5-dimethoxypentan-2 4-dione, a symmetrical intermediate; methoxyacetone could then arise from carbon atoms 2, 3 and 4 and 4, 5 and 6 of kojic acid. Experiments concerning this point are in progress. The validity of the following argument, which is based on the radioactivity in carbon atom 1 of kojic acid, remains unaffected.

| Exp No | Time grown in presence of radio-active glucose (days) | Distribution of radioactivity in kojic acid (per cent) | | | | | | Recovery of radio-activity (per cent) |
|---|---|---|---|---|---|---|---|---|
| | | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | |
| 1* | 19 | 74.0 | $C_2+C_3$ = 12.2† | | 2.7 | 5.2 | 5.9 | 105.7 |
| | | 71.5 | 5.3 | 6.7 | 4.6 | 3.6 | 8.3 | 107.8 |
| 2 | 7 | 80.1 | $C_2+C_3$ = 9.1 | | 1.1 | 2.1 | 7.7 | 106.2 |
| 3 | 5 | 73.0 | $C_2+C_3$ = 12.7 | | 1.6 | 3.4 | 9.3 | 98.4 |

* Degradation carried out in duplicate. † Calculated by difference.

Dihydroxyacetone has been considered an intermediate in the synthesis of kojic acid from glucose[3]. If free dihydroxyacetone were formed from carbon atoms 1, 2 and 3 of glucose, kojic acid would be labelled as follows: (*a*) equally in two carbon atoms (1 and 3, or 4 and 6) assuming one molecule dihydroxyacetone to be used in the synthesis; or (*b*) equally in four carbon atoms (1, 3, 4 and 6) if two molecules of dihydroxyacetone yield one of kojic acid.

Alternatively, if the glucose were degraded by the enzymes of the Embden–Meyerhof cycle, the dihydroxyacetone monophosphate would initially contain carbon-14 only in one position, provided that dihydroxyacetone phosphate is not in equilibrium with free dihydroxyacetone[4]. Since the dihydroxyacetone phosphate would be in equilibrium with glyceraldehyde phosphate, the radioactive component would be diluted by the non-radioactive carbon atoms 4, 5 and 6 of glucose. Any labelled carbon atom in the kojic acid would therefore be expected to have half the specific activity of the labelled atom in glucose. Although there is no information about the existence of the Embden–Meyerhof cycle in *A. oryzæ*, it may be significant that a zymohexase has recently been observed in *Penicillium notatum*[5].

Since the kojic acid has the same specific activity as the glucose present at the time of inoculation, and since 70–80 per cent of this activity is located in one carbon atom, we conclude that neither dihydroxyacetone nor dihydroxyacetone phosphate are precursors of kojic acid from glucose. This conclusion would be invalid if dihydroxyacetone could be obtained other than from the 1 carbon atom of glucose, or if dihydroxyacetone were to form an asymmetric complex with an enzyme of the type suggested by Ogston[6]. The mechanism by which all the carbon atoms of kojic acid become labelled is not yet apparent. Preliminary experiments show only slight incorporation of $C^{14}O_2$ and $HC^{14}OOH$.

Kojic acid can be obtained in high yield using dihydroxyacetone or glycerol as the sole carbon source[3]. Such substrates may be converted first to a simple hexose sugar as postulated by Raistrick and his colleagues[7], or alternatively, further metabolic pathways may be available for the utilization of compounds other than hexoses.

The carbon-14 methyl iodide used for preparing the labelled glucose was obtained from the Radiochemical

Centre, Amersham We are indebted to Kemball, Bishop and Co, Ltd, for generous gifts of kojic acid

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[2] Yabuta, T, *J Chem Soc Japan*, **37**, 1185 (1916)

[3] Challenger, F Klein L, and Walker, T K, *J Chem Soc*, 10 (1931) For a recent review, see Foster, J W, "Chemical Activities of Fungi", 437 (Academic Press, Inc, 1949)

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## Cordycepin, a Metabolic Product isolated from Cultures of *Cordyceps militaris* (Linn.) Link.

PREVIOUS work on *Cordyceps militaris* (Linn ) Link has been confined to morphology, life-history and relationships[1] and physiology[2] A study of possible antibiotic production by the mould was suggested by the observation that host tissue incorporated in the pseudosclerotium is resistant to decay

A mono-ascospore culture from a sporophore collected at Tollymore Park, Co Down, in the autumn of 1948 was established on a peptone–'Lemco'–glucose–agar medium The culture grew vigorously and *Cladosporium* conidial stages[3] developed after six days growth at 24° Using a medium of 'Pronutrin' and glucose in water inoculated from a bulk suspension of conidia in water, good growth was observed after two days at 24° After fifteen days, the culture solution showed slight inhibition of the growth of a strain of *B subtilis*, and after approximately twenty-four days the inhibitory activity was pronounced From the filtered culture medium we have isolated a crystalline compound to which we give the name 'cordycepin', which appears to be responsible for the total inhibitory activity

At a concentration between 10 μgm and 100 μgm per ml, cordycepin inhibits the growth of *B subtilis* NCTC 6752 in bouillon broth at 30° A small number of cells in each culture of this strain has been found to grow in concentrations of up to 1 mgm per ml

Of forty-five strains of *B subtilis* obtained from the National Collection of Type Cultures, forty-three were inhibited to varying degrees by a concentration of 1 mgm cordycepin per ml. Cordycepin had no visible effect on the growth of *B subtilis* NCTC strains 7195 and 7984 at this concentration, nor on *Staph aureus* Oxf H and various strains of *Bact coli*, *Sar lutea* and *B proteus*

Cordycepin crystallizes from water, ethanol and propanol as needles (m p 225°) It shows a marked tendency to separate with water of crystallization which is difficult to remove Analyses of cordycepin agree with the formula $C_{10}H_{13}O_3N_5$, and analyses of the crystalline picrate and the dimercurichloride agree with this formula Its aqueous solution is neutral (pH 7 1) and it exhibits an ultra-violet absorption maximum at 2600 A ($\varepsilon = 14,000$), which does not change markedly in acid or alkaline medium A molecular weight determination on cordycepin by Mrs Dorothy Hodgkin and Dr G J Pitt, using the X-ray crystallographic method, gives a value of 247 ± 10

Preliminary examination points to cordycepin containing two condensed heterocyclic rings, one of which is imidazole, the possibility that it is a purine derivative is suggested by biological evidence Biological and chemical studies on cordycepin are continuing and will be reported upon elsewhere

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## Production of Antibacterial Metabolism Solutions by Fungi

THE testing of the antibacterial activity of fungus (Basidiomycete) metabolism solutions in this Laboratory is done by floating a 10-mm disk cut from an agar-plate colony of the fungus, on 25 ml of the medium, usually potato dextrose agar or malt agar, and testing the metabolism solution so produced every five days by the method previously described[1] against agar plates bulk-seeded with the test bacteria, *Bacterium coli* and *Staphylococcus aureus* respectively The result is expressed as the diameter of the area of the bacterial inhibition in millimetres

This method produces consistent results, and is satisfactory for estimating comparative antibacterial activity under these conditions Certain workers, however, have complained that when attempting to produce larger quantities, for example, a litre, of metabolism solution, the degree of antibacterial activity is usually much less In checking this matter we evolved a system for producing relatively large quantities of metabolism solution by a simple technique which appeared to be satisfactory for all but the 'factory' scale of production

It was decided that uniformity of test results comparable with the one disk on 25 ml standard would be obtained by increasing the number of disks in proportion to the amount of medium, for example, two disks on 50 ml, four disks on 100 ml forty disks on 1 litre At the same time, however, one disk only was put on half the flasks set up at each volume of medium The accompanying table shows the results, giving the peak period of antibacterial activity and the number of days taken to reach it The experiment was done with *Hygrophorus pratensis* W 618A against *Staph aureus* only

The results are interesting in showing that, contrary to expectation, the activity of the metabolism solution was approximately the same, that is, between 20 and 24 mm, on any volume of medium from 25 to 1,000 ml and with any number of disks from 1 to 40 Moreover, in each case the peak was reached in the same time, between 25 and 30 days The degree of inhibition variation was the same in duplicate flasks in each series as in flasks in different series,

PRODUCTION OF ANTIBACTERIAL ACTIVITY IN DIFFERENT VOLUMES OF MEDIUM WITH DIFFERENT NUMBERS OF DISKS

| Vol of medium (ml ) | No of disks | Diam of inhib area (mm ) | No of days to reach peak |
|---|---|---|---|
| 25 | 1 | 20 | 25–30 |
| 100 | 1<br>4 | 21<br>22 | 25–30 |
| 200 | 1<br>8 | 21<br>22 | 25–30 |
| 400 | 1<br>16 | 21<br>22 | 25–30 |
| 1000 | 1<br>40 | 24<br>24 | 25–30 |

showing that neither the amount of medium nor the number of disks made any significant difference

Metabolism solution up to 1 litre can satisfactorily be 'planted' with one 10-mm disk, and as fifty disks can easily be taken from one plate of culture, this gives a simple and rapid method of producing metabolism solution in reasonable quantity

The experiment was repeated on a smaller scale by using 5-mm disks of *Polyporus betulinus W* 620*B*, on the ends of the range, 25 ml and 1,000 ml respectively This gave essentially the same result, an inhibition area diameter of 21 mm after 30 days This further simplifies the method in time and space, as one hundred and seventy 5-mm disks can be taken from one plate of culture

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[1] Wilkins, W H , *Ann App Biol* , 36, 257 (1949)

## Effects of Nutrition of *Marasmius urens* upon the Production of Antibiotic Substances

IT has earlier been found that species of the genus *Marasmius* produce antibiotic substances[1,2] Recent work on antibiotics has shown that *Marasmius urens* (Bull) Fr is highly active against several pathogenic bacteria (Öblom and Wallmark, unpublished) The present investigation deals with some nutritional effects upon the production of the active substances

The fungus was grown on a modification of the Czapek-Dox substrate, and the culture liquid was tested for antibacterial activity against *Staphylococcus aureus* H by the agar cup method

By using inorganic nitrogen sources (ammonium nitrate and sulphate), the active agent was produced in rather large quantities The lag period, however, was rather high, and, since growth was slow, an attempt was made to stimulate mycelium production by adding malt extract or by replacing the inorganic nitrogen source by an equivalent amount of casein digest The concentrations of malt extract tested inhibited antibiotic production completely By using casein digest at concentrations of from 60 mgm nitrogen per litre and upward, growth was stimulated, but no antibiotic substances were found to have diffused into the test medium even after three months of cultivation With low concentrations of casein digest the active agent was produced with almost the same lag phase as for the ammonium sulphate medium In this case, however, the growth was very slight After 45 days of cultivation the following results were obtained

| Amount nitrogen (mgm per litre) | | Inhibition zone (mm ) | Dry weight (mgm ) |
|---|---|---|---|
| Casein digest | 1 2 | 10 | 1 3 |
| ,, ,, | 6 | 14 | 4 0 |
| ,, ,, | 20 | 9 | 10 2 |
| ,, ,, | 40 | 8 | 14 9 |
| ,, ,, | 120 | +* | 29 |
| Ammonium sulphate | 120 | 19 | 11 |

* Only the area within the test cylinder is free from bacteria

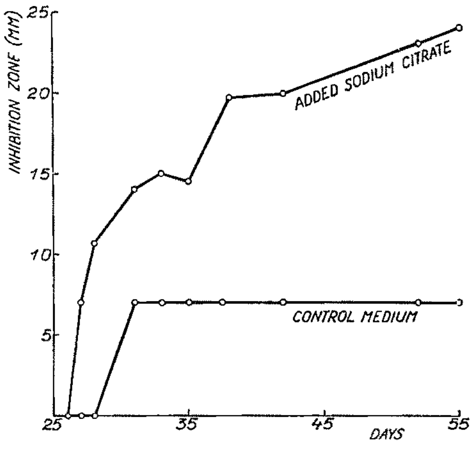
It is apparent from the table that concentrations of casein digest which support good growth simultaneously increase the lag phase of antibiotic production

Combinations of ammonium sulphate and casein digest were also tried The combinations tested not only increased mycelial growth but also increased the lag phase of antibiotic production

By transferring the mycelium developed on medium rich in casein digest (120 mgm N/lit ) to a substrate containing ammonium sulphate, a more rapid production of the active agent was obtained than when mycelium already developed on ammonium sulphate was transferred to a new ammonium sulphate substrate The transfer of mycelium developed on ammonium sulphate to a medium rich in casein digest resulted in no formation of antibiotics , only the area within the cylinder was free from bacteria The mycelia transferred to casein digest media showed an increase in growth over those transferred to ammonium sulphate Thus the inhibition of the activity caused by high amounts of casein digest was dependent on the actual concentration in the substrate and not upon the type of nitrogen available during early growth

Except by the addition of sodium citrate (see later) the most convenient method of increasing the antibiotic yield seems to be that of cultivating the fungus on a medium containing concentrations of casein digest which will promote good growth, and then transferring the mycelium to a medium containing ammonium sulphate

The inhibitory action upon the yield of antibiotic caused by high concentrations of casein digest or by malt extract could be overcome by adding sodium citrate to the substrate (see graph) The effect was obtained either by adding the citrate to the medium before inoculation or by adding it during growth



Influence of sodium citrate (final concentration 0 01 *M*) upon the production of antibiotic by *Marasmius urens* cultivated on a medium containing 120 mgm nitrogen as casein digest (the value given for the control medium represents the diameter of the test cylinder)

A final concentration of 0 01–0 02 $M$ in the substrate seems to give the best result When, after fourteen days of cultivation, sodium citrate was added to a medium containing casein digest with a concentration of 120 mgm nitrogen per litre, an inhibition zone of 17 mm was reached after seven days Stimulation by citrate was also shown on media with ammonium sulphate and asparagine as nitrogen sources In this case also the sodium citrate decreased the lag phase in production of antibiotic and increased the final concentration of antibiotics

I have also observed a stimulating effect of sodium citrate upon the production of antibiotic by *Marasmius ramealis* The antibiotic agent produced by this fungus seems not to be identical with that obtained from *M urens* It has earlier been reported by Koffler *et al* that sodium citrate exerts a stimulatory effect upon penicillin production, the degree of imulation varying with the strain used[3]

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[3] Koffler, H, Knight S G, Emerson R L, and Burris, R H, *J Bact*, **50**, 549 (1945)

## Effects of Oxygen Carriers and Oxygen Tensions on Fluoroacetate Inhibition of Citrate Utilization

AFTER comparing the action of fluoroacetate on the respiration and citrate utilization in pigeon breast muscle and nematode parasites, Massey and Rogers[1] reported that the poison had little action on the pigeon breast muscle In these experiments, methylene blue, 0 0003–0 0005$M$, was present in the brei Later experiments carried out to discover why the fluoroacetate affected the parasite tissue but not the pigeon breast muscle showed that the inhibition obtained was associated with the nature of the oxygen carriers present, and with the oxygen tension at which the experiments were carried out

Fluoroacetate (0 01$M$) inhibition of citrate utiliza[illegible]n in pigeon breast muscle in air was greatest (100 per cent) when cytochrome *c* ($5 \times 10^{-6}M$) was added With methylene blue (0 0005$M$) inhibitions of 20–30 per cent were obtained, without added carrier, the inhibition was about 50 per cent

The oxygen tension had a profound effect on the inhibition in pigeon breast muscle mince to which no carrier had been added Under anaerobic conditions, inhibition has not been noted, in air, inhibition was about 50 per cent, and in oxygen about 100 per cent

These results suggested that there might be a relationship between the oxidation-reduction potential and the efficiency of the fluoroacetate as an inhibitor Accordingly, the inhibition of citrate utilization in the presence of fluoroacetate (0 01$M$) was examined at different oxidation-reduction potentials, maintained by electrolysis by the method of Hanke and Katz[2] At $E_h$ levels below + 50 mV, fluoroacetate caused inhibitions of 0–25 per cent At levels above + 120 mV, the inhibition varied from 65 to 100 per cent

It has been suggested by Liébecq and Peters that fluoroacetate itself is not an inhibitor, but is activated and brought into the tricarboxylic acid cycle to form a fluoro-compound, probably fluorocitrate, which causes a 'jamming' of the cycle Further experiments were carried out to discover whether the oxygen tension affected the formation of the fluoro-compound, or the actual inhibiting reaction, or both The pigeon breast muscle mince, which contained 0 0025$M$ oxalacetate, with and without 0 0025$M$ fluoroacetate, was pre-incubated for 15 min under oxygen, or under oxygen-free nitrogen Thereafter, the citrate utilization, occurring under air, oxygen or nitrogen, during a period of 30 min was determined The results, which are shown in the accompanying table, showed that high oxygen tensions favoured both the formation of the fluoro-compound and its activity as an inhibitor

| | | | | |
|---|---|---|---|---|
| Gas phase, pre-incubation period | Nitrogen | Oxygen | Oxygen | Oxygen |
| Gas phase, experimental period | Air | Air | Oxygen | Nitrogen |
| Inhibition of citrate utilization | 26 per cent | 86 per cent | 100 per cent | Nil |

A full account of this investigation, which was part of the research programme of the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, will be published elsewhere

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July 5

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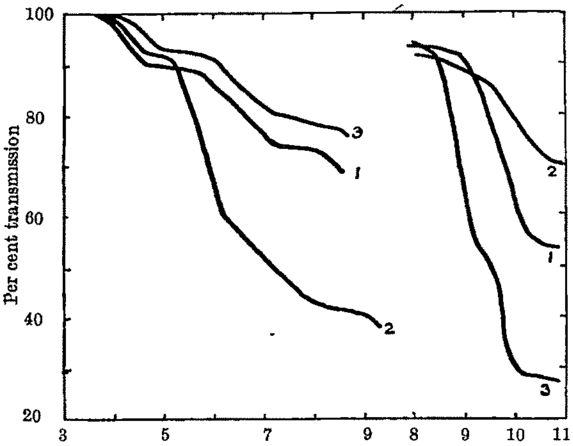
## Fractionation of Serum Proteins with a Quaternary Ammonium Detergent

THE fractionation of serum proteins with the aid of quaternary ammonium compounds has met with difficulties, because the detergent,protein ratio must be maintained at a very constant level[1] We have shown that this is no longer necessary if 'Desogen' (methylphenyl dodecyltrimethyl-ammonium methosulphate, Geigy S A, Basle) is used Separation into at least four components can be performed by the following method

To 2 ml diluted human serum ((*a*) 1 100 in 1 00 per cent sodium chloride for *p*H 4–8, or (*b*) 1 500 in 0 03 per cent sodium chloride for *p*H 8–11) is added 1 ml Michaelis buffer[2] of constant ionic strength 0 1 After mixing, 1 ml of 0 15 per cent 'Desogen' solution in distilled water is added A very faint, stable turbidity has completely developed after 15 min, and the transmission is read in a photo-electric colorimeter at 620 m

For the *p*H range 8–11 the sodium acetate in the Michaelis buffer is replaced by glycine The minimum admissible detergent/protein ratio is 1 0, the maximum varying from 4 0 at *p*H 8 5 to about 30 for *p*H 5 0

The results are illustrated by the accompanying graph The first step in the transmission – *p*H curve



Transmission – *p*H curves

(1) Normal human serum, (2) nephrotic serum (high β-, low γ-globulin, low albumin content), (3) myelomic serum (very high γ globulin content)

Left-hand curves 2 ml serum (1 100 in 1 00 per cent sodium chloride) + 1 ml Michaelis buffer + 1 ml 0 15 per cent 'Desogen' solution

Right-hand curves 2 ml serum (1 500 in 0 03 per cent sodium chloride) + 1 ml Michaelis buffer + 1 ml 0 10 per cent 'Desogen' solution

is caused by α-globulin (*p*H 4–5), the second (5–7) by β-globulin, γ-globulin is precipitated at *p*H 8 5–9 5, and finally albumin at 9 5–10 5 The boundary between albumin and γ-globulin is not sharp The identity of the steps was proved by electrophoretic analysis Sometimes the β-fraction is divided into two or three minor fractions

A clear distinction between sera of different protein composition can be made, as is shown by curves 2 and 3 Approximate estimations of the quantities of the various components can be carried out by comparison with the normal serum curve

The possibilities of making the method quantitative and obtaining better separation of the components are being studied Details of this work will be published elsewhere

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## Immunization against *Erysipelothrix rhusiopathiæ* with Killed Vaccine

TRAUB[1] appears to have elaborated a killed vaccine capable of evoking an effective immunity against swine erysipelas It consists essentially of formalin-killed bacterial cells and other antigenic substances present in liquid cultures precipitated by means of aluminium hydroxide gel However, he does not give his method in sufficient detail to enable it to be faithfully repeated Nevertheless, he emphasizes that (1) only certain strains of *E rhusiopathiæ* are able to produce active vaccine, (2) vaccine activity is dependent upon the precipitation both of the bacterial cells and of a soluble antigen present in the medium An efficient vaccine immunizes mice in doses of 0 2 ml after dilution 1/16, 1/64 or even 1/256 in aluminium hydroxide gel It also immunizes pigs against experimental infections produced by the method of Fortner and Dinter[2] and has given satisfactory results in the field[3]

In experiments upon similar lines, I have produced vaccine having for mice an immunizing potency of the same order as that of Traub's vaccine It has been possible to confirm that only a small proportion of strains of *E rhusiopathiæ* is of value for vaccine production However, it would seem that the majority of virulent strains contains some cells which will pass through 'Gradocol' membranes of porosity 0 8μ or 0 75μ, and that the growths initiated from filtrates of two strains have yielded vaccines of higher activity than those made from the corresponding unfiltered cultures It is uncertain whether efficient vaccines would be obtained with greater consistency if strains were regularly grown from filtrates both in maintaining them and in producing vaccines

Although Traub claimed that soluble antigen wa present in growths yielding efficient vaccines, a claim formerly accepted by myself[4], equally efficient vaccines have now been produced from formalin-killed cells, centrifuged and re-suspended in fresh medium Moreover, while filtrates through membranes of 1 0μ (about $10^6$ cells per ml ) and even 0 75μ (about $10^2$ cells per ml ) produced, after sterilization with formalin, sera in rabbits capable of passively protecting mice against infection, 0 2μ filtrates failed to produce such antibodies Thus, it would seem that under the conditions employed, soluble antigen was absent My earlier experiences would seem to be explained by the high antigenic activity of the small killed cells remaining undeposited after centrifugation of formalin-killed growths and by the ability of a very small proportion of viable cells to pass bacterial filters and to evoke sub-clinical infections upon introducing them into susceptible hosts To be assured that filtrates do not contain any viable organisms is a matter of great difficulty in the case of *E rhusiopathiæ*, as has been clearly demonstrated in the investigations following upon the infection of sheep with horse serum accidentally contaminated with bacteria of this species[5,6]

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## Hormonal Control of Liver Catalase

RECENT investigations of the depressing action of tumours on liver catalase have suggested that this was due to the release by tumours into the circulation of some toxic material[1,2] Working with mice, a sex difference in normal liver catalase-level (male > female) as well as a larger percentage depression in males 48 hr after the injection of tumour material have been observed[2] These results indicated some degree of hormonal control of liver catalase-level, and the suggestion was made that the effect of castration and adrenalectomy might be worth investigating

In the preliminary experiments described below, stock albino mice were used and catalase estimated

EFFECT ON LIVER CATALASE OF CASTRATION, OVARIECTOMY AND ADRENALECTOMY

| | Controls | Treated | % depression (on arithmetic means) |
|---|---|---|---|
| ***Males*** | | | |
| Castration (catalase after 48 hr ) | 154±12 (8) | 110± 9 (9) | 29 |
| Castration (catalase after 4 days) | 137±13 (8) | 83± 4 (5) | 39 |
| Castration adrenalectomy 48 hr later, catalase after a further 48 hr | 137±13 (8) | 48± 1 (7) | 65 |
| ***Females*** | | | |
| Ovariectomy | 111± 8 (7) | 117±10 (6) | No significant change |
| Unilateral adrenalectomy | 119± 6 (14) | 84± 3 (7) | 29 |
| Bilateral adrenalectomy (Catalase-levels after 48 hr ) | 119± 6 (14) | 54± 5 (9) | 55 |

Results are presented as arithmetic means ± standard error of means The number of animals in the groups are given in brackets Catalase activities in arbitrary units per mgm nitrogen

according to the method of Adams[2] Males were castrated, and females ovariectomized, and the liver catalase-level was determined 48 hr afterwards The accompanying table shows that while there was no significant change in females, a depression of nearly 30 per cent was observed in the males Adrenalectomy was tried first in females to avoid the possible complicating effects of testicular hormones Unilateral adrenalectomy produced a 29 per cent depression and bilateral adrenalectomy a 55 per cent depression Finally, a group of males was castrated, half the group adrenalectomized 48 hr later and the catalase-level of the two groups determined after a further 48 hr The castrated animals showed a 39 per cent depression in activity and the castrated and adrenalectomized animals a 65 per cent depression

These preliminary experiments indicate the importance of hormonal mechanisms in maintaining a normal level of liver catalase The work is proceeding, and experiments to determine the point at which tumours act in the system are now in progress It is tentatively suggested that the action of the catalase-depressing material released from tumours is to prevent the liver from responding to the normal hormonal stimuli

Shortly before this communication was submitted, Begg and Reynolds[3] reported that adrenalectomy in rats resulted in a depression of liver catalase-activity two to three weeks after operation

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Aug 10

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## South African Fossil Hominoids

THE opening sentences of the recent note[1] in which Prof Le Gros Clark records certain observations about the milk canines of the South African fossil hominoids seem to imply that he has misunderstood both the sense and aim of my previous communication[2] In the interests of accuracy, may I be permitted to reiterate certain facts ?

The descriptions of the South African fossil teeth which he, Dr Broom and Prof Dart have from time to time provided, incorporate statements about presumedly significant metrical differences between the fossils and existing apes The clearly stated purpose of my previous note, and of the work which Mr Ashton and myself have recently published[3], was to define, in statistical terms, the significance of the divergences between the *"recorded dimensions and indices"* of the fossil teeth and those of existing anthropoid apes The information available to us about the fossils was, as Prof Le Gros Clark remarks[4], either based on measurements of plaster casts, or taken at second hand, and in this respect was apparently the same in kind as the information which forms the subject of his new note The variance of dental dimensions in existing apes can fortunately be determined directly What we showed, and what can again be stated categorically, is that the recorded dimensions which we quoted of the milk canines of *Australopithecus africanus* and *Paranthropus robustus* do not differ significantly (at a level of significance $P \leqslant 0\ 02$) from those of the chimpanzee, while those of *Paranthropus crassidens* do not deviate from the orang The new information provided by Prof Le Gros Clark is highly interesting and welcome , but it does not alter this fact Nowhere have I either declared or implied that three or four main dimensions of a tooth define all its characteristics, and I have already expressed the view[3] that among the so-called qualitative characteristics of the fossil ape teeth which might be expressed metrically, it is to be expected that some would be better matched in the human than in the ape This Prof Le Gros Clark appears to have shown in the case of the milk canines

In his account of the new monograph by Dr Broom, Mr Robinson and Dr Schepers[5], he implies, however, that the attempts we have made to subject to statistical analysis some of the dimensions that have been published of the Australopithecine fossils were not only "premature" but also have led "to certain inconclusive results" It can scarcely be premature to examine the accuracy of scientific statements If it is written that a given dental dimension in a fossil anthropoid is, say, 10 mm and that this is significantly smaller than the corresponding dimension in the chimpanzee, a fact is implied both about the fossil and about chimpanzees If examination then shows that a dimension of 10 mm could be expected to occur in chimpanzees, the presumed difference falls to the ground Unfortunately, published statements about the teeth of the fossils in relation to those of living apes have now been shown to be anything but free of such shortcomings

Prof Le Gros Clark asks, as he has before, to be directed to some imaginary and unique specimen of an extant ape which he feels ought to be produced to support our statements to the effect that this or that group of dental dimensions in a fossil species does not differ significantly from the corresponding group of some existing ape His request is unreal Variation is a characteristic of all living matter, and the South African fossil anthropoids, one can scarcely doubt, were at least as variable as are existing apes A main purpose of modern biometrical and statistical methods is to express variation in a way which permits one to determine whether a central trend in one group differs significantly from that in another

The use of statistics is scarcely likely to reveal one skull which exactly reproduces the dimensional characteristics of another

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Nov 7

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## *Iso*propyl Alcohol in Cows Suffering from Acetonæmia

We wish to record the finding of considerable amounts of *iso*propyl alcohol in the blood, milk and rumen contents of cows suffering from acetonæmia, whereas there appears to be none present in normal animals This means that the figures given hitherto for β-hydroxybutyric acid in the literature on that condition are probably misleading, as by most of the usual methods of analysis *iso*propyl alcohol would be estimated with that fraction Moreover, in view of its close relationship to acetone, *iso*propyl alcohol might be either a precursor or a metabolic product of that substance If the former is the case, it would necessitate an entirely new approach to the problem of the development of ketone bodies in this disease

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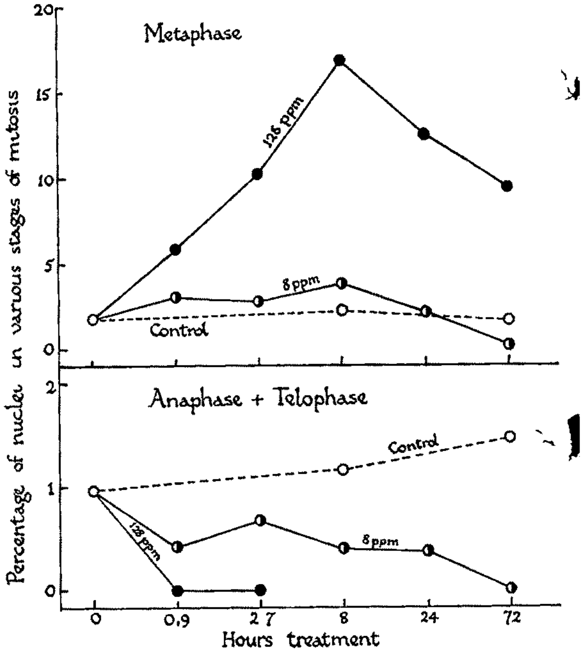
## Inhibition of Growth of Apical Meristems by Ethyl Phenylcarbamate

Templeman and Sexton[1] were the first to show that ethyl and *iso*propyl phenylcarbamates were selectively toxic to higher plants and therefore potentially valuable as herbicides Since then, Ennis[2], Ivens and Blackman[3] and Doxey[4] have reported on the mitotic effects induced by these compounds It has generally been assumed that their action is primarily on the spindle of dividing cells, but a continuation of the work at Oxford suggests that other factors may be involved

In an examination of the effects of ethyl phenylcarbamate on the growth and mitosis of the root apices of various species, results have been obtained which indicate that in a relatively susceptible plant, such as barley, the primary action may not be on the spindle but on some other function of the cell, so that cell division and growth may be inhibited by concentrations which do not interfere with the spindle

The type of result which has led to this interpretation is illustrated in the accompanying figure, where the proportion of nuclei visible in longitudinal sections of the root tips of barley in (*a*) 'metaphase' and (*b*) 'anaphase plus telophase' are given for different treatments with ethyl phenylcarbamate 'Metaphase' represents the sum of the normal metaphases plus the blocked metaphases which are a consequence of the delay in chromatid separation due to the failure of the spindle mechanism The anaphase and telophase figures are related to the extension growth of the root tips and represent normal mitoses The arrest of normal division is reflected in the reduction of the anaphase plus telophase figures, with the highest concentration of 128 p p m this number falls to zero within an hour of treatment, whereas with 8 p p m a comparable reduction does not take place for more than twenty-four hours



The effects of various periods of treatment with two concentrations of ethyl phenylcarbamate on the proportions of nuclei in 'metaphase' and in 'anaphase + telophase', visible in sections of barley root tips

Since the blocked metaphase condition persists longer than the normal metaphase, it would be expected that, at concentrations affecting the spindle, the number of metaphases would increase Thus, if the interruption of normal cell division were dependent solely upon spindle failure, the reduction in the total number of anaphases and telophases should be accompanied by a rise in the number of metaphases While this expected rise occurs at the higher concentration, yet with the lower concentration the number of metaphases does not rise, instead the number falls to zero after seventy-two hours, although by then normal division and growth have been irreversibly stopped

Following prolonged treatment, there is also a fall in metaphase numbers with the higher concentration, and the tissues finally die It is probable that the primary toxic action which reduces the number of metaphases as well as of anaphases and telophases comes into play earlier at higher concentrations, but that these toxic effects are masked to some extent by the effects on the spindle

The less extensive investigations so far carried out with the pea, a relatively resistant species, show that similar cytological aberrations occur but that much higher concentrations are required than for barley, and there is no evidence that pea root growth is inhibited at concentrations below those affecting the spindle.

It is suggested that the inhibition of root growth may be the result both of an effect on the spindle and an effect on some metabolic activity connected with mitosis, similar to the 'poison' effect of various spindle-inhibiting substances reported by Levan and Ostergren[5,6]. With these compounds the poison effect was only brought about by concentrations higher than those required to affect the spindle, but the relation between the threshold concentrations for the two effects varied considerably between different compounds.

These findings indicate that the selective toxicity of phenylcarbamates is not necessarily related to differential effects on the spindle and suggest that the assessment of toxicity in terms of mitotic aberrations alone may give misleading results.

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Oct. 25.

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## Inoculation of Plants with Vascular Pathogens

*Systemic infection of young plants.* During the course of studies on the effect of mineral nutrition on the reaction of plants to infection with *Verticillium albo-atrum* Reinke and Berth, it became necessary to secure systemic infection of young plants without introducing the pathogen through the roots. The following method was therefore devised, using tomatoes as test plants.

Tomato seeds were sown at a spacing of 1½ in × 1½ in. in boxes of sterilized soil. When the young plants were about 3 in. high, they were cut off at soil-level and stood with the basal ½-in. immersed in a spore suspension of *V. albo-atrum*. This spore suspension was standardized by means of a hæmocytometer and contained about 50,000 spores per ml. The tomato cuttings were left in the spore suspension for 24 hr., then removed and washed for 1 hr. in running water to remove spores adhering to the stem surface. The cuttings were then rooted in small pots containing a peat–sand mixture or pure sharp sand. Tests of sample plants for the presence of *Verticillium* immediately after treatment showed that the fungus could be isolated from the vascular tissue throughout the stem.

Abundant roots were formed within ten days, and the rooted cuttings were then potted on for use in the experiments.

The first noticeable effect of the spore treatment was stunting of the treated plants which, after rooting, were usually half to two-thirds the size of the control plants grown from cuttings that had been stood in water only. Although initially stunted, the treated plants afterwards grew normally but were less forward than the control plants. Under suitable manurial and temperature conditions for the expression of wilt, typical symptoms were first seen on the treated plants four to five weeks after inoculation.

Although particularly useful with tomatoes owing to their ready rooting, the method has proved applicable to several other plants that can grow from cuttings. I used it in 1938 to infect carnation cuttings with *Verticillium cinerescens* Woll. Plants grown from these cuttings showed similar symptoms to those grown from cuttings taken from naturally infected plants. Antirrhinum and aster plants have been similarly infected with *V. albo-atrum* and showed wilt symptoms within two to three weeks after inoculation.

No tests have been made with other vascular pathogens, but the method seems likely to be of use with any organism which invades the vascular tract. It should prove of value in investigations requiring rapid and uniform inoculation of plants with such organisms, as it enables large numbers of infected plants to be produced and obviates some of the sources of variation inherent in root-inoculation methods. Two such types of investigation are the screening of varieties for disease resistance and tests of chemicals for therapeutant effects. The value of the method for therapeutant testing is now being studied at East Malling.

*Infection of single stems of mature plants.* During experiments involving the inoculation of hop stems with *Verticillium albo-atrum*, difficulty was experienced in obtaining uniform infection by the usual method of insertion of fungal inoculum into a wound in the stem. A method was therefore devised making use of the pith cavity of the stem internodes as a site for a large dose of inoculum. The internodes of hop stems are hollow, but the pith cavity is sealed at the nodes. The inoculum used was a suspension of spores of *V. albo-atrum* (approximately 50,000 per ml.) made up in a 0·5 per cent solution of agar-agar in water. The spores were added to the agar when this was at a temperature of 40° C. and thus still liquid. The agar was then allowed to cool and formed a semi-solid gel. A hypodermic syringe was filled with the suspension and fitted with a fine needle.

A large needle was passed through the top of the hollow portion of the internode and withdrawn, leaving two holes leading to the pith cavity. The needle of the syringe was then carefully inserted into the pith cavity at the bottom of the internode and the agar spore suspension injected into the cavity. As the agar entered, the air escaped from the upper holes and the injection was complete when small globules of agar appeared at these holes. Owing to its semi-solid state, the agar remained in the cavity, but the holes were closed with crepe rubber bandage to exclude air. If extra large doses of inoculum were required, several internodes were inoculated on each stem in the manner described.

Many inoculations were made by this method and were invariably successful, typical wilt symptoms usually appearing above the selected internode after three to four weeks. The method could presumably be used on other hollow-stemmed plants and, since the inoculum is protected by the outer tissues of the stem, it seems likely to be more efficient than some other techniques.

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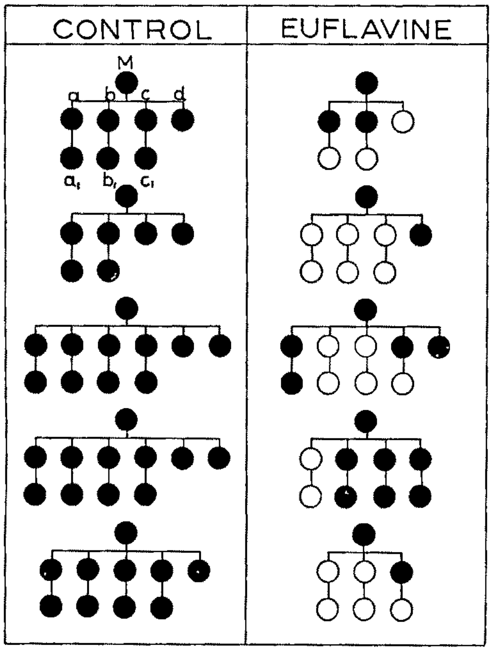
## Direct Demonstration of the Mutagenic Action of Euflavine on Baker's Yeast

It has been shown in a series of recent papers[1-3] that baker's yeast grown in the presence of acriflavine undergoes a profound modification. After a few generations of growth in the presence of the dye, the culture is found to be composed almost exclusively of cells which are deficient in some respiratory enzymes (cytochrome oxidase, succinic dehydrogenase) and which are consequently unable to oxidize glucose. Cells presenting these characteristics have been isolated in pure cultures which have been maintained in normal medium for several years. Their respiratory deficiency has proved to be permanent.

Although similar mutant cells arise spontaneously with a rather high frequency under normal cultural conditions, we have claimed, on the basis of a quantitative study, that the described predominance of mutant cells in cultures grown in the presence of acriflavine is due not to a selective but to a mutagenic action of the dye[4].

This conclusion has now been subjected to a direct test. Single cells from a normal culture of *Saccharomyces cerevisiae* (diploid strain *B*-II) are placed with the help of a micromanipulator in the microdissection chamber in a droplet of culture medium containing $10^{-6}$ parts of 2–8 diamino 10 methyl acridinium chloride (purified euflavine)[5]. The budding of these cells is observed under the microscope, the light beam being filtered through a cuvette (30 mm.) containing a concentrated solution of acriflavine. The successive daughter cells (*a*, *b*, *c*, *d*, etc., in the diagram) are detached from the mother cell (*M*) as they form, rinsed and removed to a droplet of normal medium. The mother cell, on the other hand, is either left in the drop of euflavine or transferred to a fresh drop of the same medium kept up to this time in the dark. Similarly, one second-generation bud is isolated from each of the daughter cells. Finally, at the end of the experiment, the mother cell itself is transferred to normal medium.



Descendants of isolated yeast cells proliferating in the presence or absence of euflavine. Black circles, normal cells; white circles, mutant cells

Similar isolations are performed in the absence of euflavine to provide controls.

After the isolated cells have formed sizable clones, the latter are transferred from the microdissection chamber on to normal medium. Thus stock cultures are established, which can be subjected to the Nadi reaction for indophenoloxidase, this reaction serving as a criterion of the normal or mutant character of the clones[3].

The diagram gives the results of five such experiments and their controls in the form of 'pedigrees'. It can be seen that among 42 descendants of the 5 control cells no spontaneous mutants were found. Among 35 descendants of the 5 cells placed in euflavine, 21 gave rise to mutant clones. Since the experimental arrangement offers no opportunity for selection (aside from cell mortality which was zero), the mutagenic action of acridines is unequivocally confirmed by these experiments.

Consideration of the cell lineages shown in the diagram seems to warrant the following deductions concerning the nature of the mutation process. We notice that in the experiment all mother cells, after producing several mutant buds, remained capable of producing some normal ones and, in any event, remained normal themselves. This makes the hypothesis of a gene mutation, or of a mutation of any cell constituent for that matter, very unlikely. The appearance of mutant cells as a consequence of the euflavine treatment is best accounted for by assuming that an auto-reproducing cytoplasmic component, necessary for the synthesis of the respiratory enzymes in question, has not been included in some of the buds. Since a cell can alternately produce mutant and normal buds, this cytoplasmic component must be ascribed a particulate nature. All these conclusions conform with and reinforce those previously drawn from the quantitative study of the action of acriflavine and from the results of the crosses between normal and mutant cells[4,6].

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July 26.

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[5] This compound, kindly given to us by Prof. Adrien Albert, has been found to be particularly active (Marcovich, H., unpublished).

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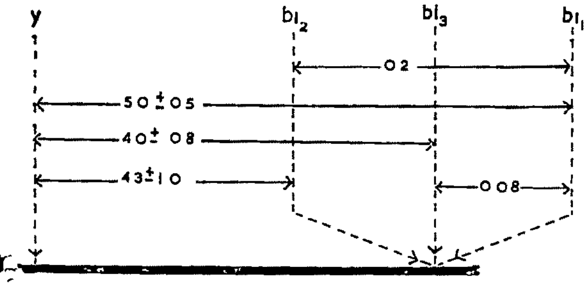
## Search for Linkage between Genes determining a Vitamin Requirement

Whether genes are distributed at random between and along the chromosomes, or show some systematic arrangement related to their function in the biochemistry and morphogenesis of the organism, has long been a crucial problem in genetics[1-4]. The location of genes in relation to their detectable effects in organisms as varied as maize, *Drosophila*, the mouse, man and *Neurospora* suggests that "if such a distribution [non-random] exists it does not leap to the eye"[5]. However, there have been enough exceptions to suggest that the problem is by no means settled Cases are known of closely linked genes having similar effects on the phenotype, for example, 'lozenge'[6] and 'bithorax'[1] in *Drosophila*, 'brachyury' in the mouse[7], perhaps *Rh* in man[8] and recently nicotinic acid requirement in *Neurospora*[9] In all these cases linkage was not expected on any reasonable working hypothesis and was discovered accidentally

A working hypothesis for the deliberate search for linkage[10] is that close linkage might be expected between some of the genes acting on any one series of milli-micromolar biochemical reactions[11] A first deliberate search for linkage prompted by this working hypothesis has led to positive results

Each of three mutant strains of *Aspergillus nidulans* requires biotin or desthiobiotin for growth but does not respond to pimelic acid, and attempts at further characterization of their growth-factor requirements have so far been unsuccessful Each strain differs from wild type in a single allele the three alleles are not allelomorphic of one another, their loci are in a chromosome segment about 0 2 Morgan in 'length' and the order of these loci has been established The evidence is as follows (1) Crosses two by two of the strains gave recombinants not requiring biotin ('prototrophs') (2) The 'prototrophs' derive from crossing-over, as shown by the use of additional markers on the same chromosome (5, 7 and 15 Morgans away), recombination between the biotin loci is associated in the expected way with recombination for these other loci The order and 'distances' of the three genes relative to one another and to the locus *y* (spore colour[12]) are as follows



Map of the chromosome region of *Aspergillus nidulans* including the three '*bi*' loci (Distances in Morgans)

That a first deliberate search based on the above-mentioned working hypothesis should be successful is scarcely likely to be a matter of chance This search is now being extended to three further series of mutants requiring other vitamin-like substances

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# A New Design of Microsyringe Tip for the Instrumental Insemination of Queen Honey-bees

IN 1927, Watson[1] described the construction of a number of glass microsyringes which he had used for the instrumental insemination of queen honey-bees The tips of these syringes were straight and the operator holds one of these syringes in line with the long axis of the queen when introducing it into her vagina This type of glass syringe was simplified and improved during the course of time both by Watson himself and also by Nolan[2] and others, but really satisfactory results were infrequently obtained at this stage

In 1944, Laidlaw[3] published the results of his investigation of the morphology of the genitalia of the queen honey-bee, as a result of which he recognized the importance of placing the syringe tip beyond a membranous structure known as the valve-fold, which normally closes the median oviduct, before introducing the semen Mackensen and Roberts[4] afterwards developed the technique to the stage where it became possible to produce fertilized queens in numbers This technique involves depression of the valve-fold of the queen with a probe which usually has a ⌈-shaped tip The tip of the probe is introduced into the median oviduct and beyond the valve-fold, and the tip of the microsyringe is in turn introduced beyond the valve-fold while the probe is still in place The probe is then removed without disturbing the syringe tip, and the semen is injected The tip of the type of syringe employed by Mackensen and Roberts[4] was straight and was first constructed of glass, later of the transparent plastic 'Lucite'[5], and the syringe was fitted with a metal plunger working in the lumen of the tip itself

A year or two ago, a syringe in which the uptake and expulsion of the semen were controlled by the mechanical distortion of a rubber diaphragm situated in the body of the syringe was introduced by the American workers

It has for some time appeared to me that the technique as developed by Mackensen and Roberts could be greatly simplified by the use of an instrument which would serve both as a probe for depression of the valve-fold and as a syringe for introduction of the semen and which could be held in the hand, instead of in a clamp, throughout the operation An experimental plunger-type syringe-probe of this kind with the last 4–5 mm of the tip, which was made of polythene, bent round in one plane at an angle of about 55° to the longitudinal axis was constructed in 1949, and I have successfully inseminated several queens with it The material from which the tip of this syringe was made was found, however, to be rather too flexible for this purpose and also difficult to polish satisfactorily Furthermore, although introduction of the tip of this syringe beyond the valve-fold into the median oviduct of a queen was easily carried out without the use of a probe and with the syringe held in the hand throughout, it was found to be extremely difficult to hold the syringe steady in the hand while the plunger was operated and the semen injected

I explained the idea of a hook-type syringe-probe to several skilled instrument makers and one of them, Mr R Jarvis of Rowlands Castle, Hants, has recently succeeded in producing a syringe to which the new hooked-type of tip, made either of glass or 'Perspex', can be fitted and in which the uptake and expulsion of the semen is effected by means of distortion of a rubber diaphragm and controlled by a foot pedal, thus leaving both hands free to hold and manipulate the syringe Thanks to the kindness of Mr Jarvis, I have now had an opportunity of using this syringe and have found that it greatly simplifies the process of insemination Not only does it avoid the necessity of using a separate probe, but it is also more easily and quickly introduced into the queen than the older type of syringe with a straight tip It also seems probable that the percentage of queens damaged during insemination will be reduced by the use of this syringe, details of the construction of which it is hoped Mr Jarvis will publish shortly

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## Breeding Female of the Pipefish

THE following notes on the breeding female of the pipefish *Nerophis lumbriciformis* (Pennant) may be of interest to zoologists One in breeding dress was taken in the *Laminaria* zone early in April 1946, at Mahee Island, Co. Down, Northern Ireland It was in the company of several other females of normal appearance

The fish was a drab olive-green colour and possessed a large number of minute black spots arranged along the scutes of the tail The animal had a slightly translucent appearance The head showed the same pattern of dark lines as in the normal female The snout was dark grey in colour The dorsal and ventral surfaces of the body each bore a median longitudinal keel Smitt[1] described the dorsal keel as smaller than the ventral In the Mahee Island specimen the dorsal keel is the larger Duncker[2] stated that the body of the female is laterally compressed but did not record the presence of keels

In the Mahee Island specimen the dorsal carina commenced behind the head and passed posteriorly as far as the region immediately in front of the dorsal fin The ventral carina, which was only one-third of the depth of the dorsal, extended from behind the opercula almost to the vent Examination of an X-ray plate failed to show any evidence of skeletal support of these structures

The breeding female is rare and has not been previously recorded in this locality

The specimen has been deposited in the British Museum (Natural History) I am indebted to Dr E Trewavas, of the Museum, for assistance in the identification of the fish

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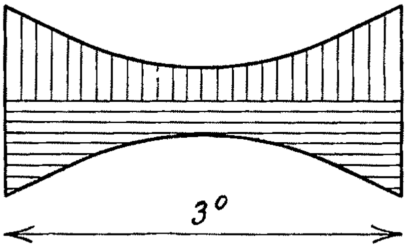
## Properties of the Human Eye with respect to Linearly and Circularly Polarized Light

IT was discovered by Haidinger[1] in 1844 that the human eye can detect the direction of polarization of linearly polarized light Looking at a white field through a nicol, one sees a yellow figure, which can be described as a figure 8 perpendicular to the plane containing the electrical vector (direction of polarization) Though this phenomenon has been studied by several authors, no quantitative measurements have been made hitherto An analysis of the phenomena observed with the arrangement shown in the accompanying figure elucidates the basic properties of the eye which give rise to the 'Haidinger brushes'



The fields of the photometer are illuminated by the same wave-length, the directions of polarization being given by the lines When a brightness match has been made, the directions of polarization are rotated through 90° without changing the intensities This is achieved by rotating a half-wave plate of a double-refracting substance (mica) in front of the exit pupil through 45° This rotation is found to disturb the brightness match The lower field appears to be *darker* now than the upper field Its brightness has to be corrected by a factor *f* in order to restore the match At the optimal wave-length of 460 mμ this factor was found to vary from 1 05 to 1 30 for ten observers

The following points were noted (1) The phenomenon does not depend on the orientation (vertical, horizontal, etc ) of the test-field, (2) it disappears when the directions of polarization make an angle of 45° with the boundary (angle between the directions of polarization of the two fields still 90°), (3) the spectral variation of *f* is identical with the absorption curve of the yellow pigment, its deviation from the sensitivity curve of the blue-receptors exceeds the experimental errors

These measurements are easily explained by the assumption that the yellow pigment is dichroitic, like the well-known 'Polaroid' filters Obviously the arrangement of the molecules is not quite at random, but a small part (about 5 per cent) is arranged in a radial symmetrical fashion (probably perpendicular to the radius vector), so that the component with a tangential direction of polarization is more strongly absorbed than the radial component This agrees with Helmholtz's[2] explanation of the 'Haidinger brushes'

We carried out a similar experiment with circularly polarized light A quarter-wave plate in front of the exit pupil instead of the half-wave plate transforms the linearly polarized light into circularly polarized light The sense of rotation is reversed by turning the quarter-wave plate through 90° We found that this rotation disturbed the brightness match also, but this proved to depend on the orientation of the test-field

It was possible to explain this part of the measurements by considering the optical anisotropy of the refracting media of the eye, by which the circularly polarized incident light is transformed again into linearly or elliptically polarized light This anisotropy was discovered by Boehm[3]

The measurements will be reported in more detail in *Physica*

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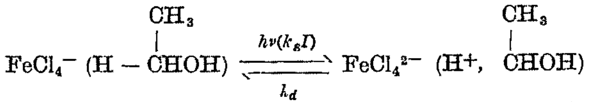
## Photoreduction of $FeCl_4^-$ in Alcohol

IN aqueous solutions containing ferric ions and chloride ions below molar concentration, $FeCl^{2+}$ is the main species present[1] , in ethyl alcohol, on the other hand, above a $10^{-2}$ molar concentration of lithium chloride (LiCl) the ion $FeCl_4^-$ is practically the only complex occurring We have shown by a spectrophotometric study of the system $Fe(ClO_4)_3 +$ LiCl in alcohol in conjunction with conductometric titrations that in a concentration range of $10^{-2}$–1 *M* lithium chloride (the ferric perchlorate concentration being of the order of $10^{-4}$ *M*) the anion complex $FeCl_4^-$ is quantitatively formed The absorption spectrum of $FeCl_4^-$ is distinct from that of the lower ferric chloride, the ferric hydroxide and the ferric ethoxide compounds $FeCl_4^-$ (as shown spectrophotometrically) occurs also in ether extracts of ferric chloride solutions in 6 *M* aqueous hydrochloric acid In previous work[2-5] the occurrence of $FeCl_4^-$ has not been recognized, and as a result the experiments were wrongly interpreted

In an investigation of the photoreduction of this complex in alcohol, we used the mercury line 365 mμ light source and followed the reaction by determining the absorption at right-angles of a parallel beam of light from a small tungsten lamp with a suitable filter, measuring the transmission by means of a photomultiplier tube (*R C A 931 A*). In view of the experimental results we postulate the following mechanism

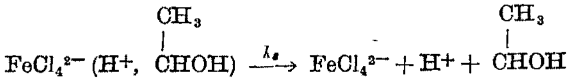
1. Photo-excitation and primary dark back-reaction



$$FeCl_4^-\ (H-\overset{\overset{\textstyle CH_3}{|}}{C}HOH) \underset{k_d}{\overset{h\nu(k_\varepsilon I)}{\rightleftharpoons}} FeCl_4^{2-}\ (H^+,\ \overset{\overset{\textstyle CH_3}{|}}{C}HOH)$$

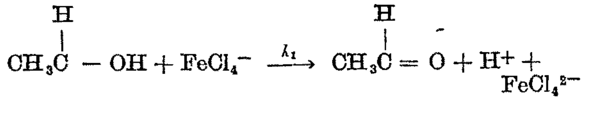
(primary product = *A*)

2 Separation of the primary product



$$FeCl_4^{2-}\,(H^+,\ \overset{\overset{\textstyle CH_3}{|}}{C}HOH) \xrightarrow{k_s} FeCl_4^{2-} + H^+ + \overset{\overset{\textstyle CH_3}{|}}{C}HOH$$

3 Reduction of $FeCl_4^-$ by the free radical



$$CH_3\overset{\overset{\textstyle H}{|}}{C}-OH + FeCl_4^- \xrightarrow{k_1} CH_3\overset{\overset{\textstyle H}{|}}{C}=O + H^+ + FeCl_4^{2-}$$

4 Combination of free radicals

$$2CH_3C\,HOH \xrightarrow{k_2} \text{products}$$

Stationary state kinetics based on the above scheme (assuming $\frac{dA}{dt} = 0$, $\frac{d[CH_3\ \ CHOH]}{dt} = 0$) lead to the following equation

$$\gamma - \frac{k_s}{k_d + k_s} = \frac{k_1C\sqrt{V}}{\sqrt{k_2k_\varepsilon I}}\sqrt{\frac{2k_s}{k_d + k_s} - \gamma},$$

where $C = [FeCl_4^-]$, $V$ = volume, and $\gamma$ (net quantum yield) = $\frac{d[FeCl_4^-]}{dt}\ \ \frac{V}{k_\varepsilon I}$ Under conditions when $\frac{\sqrt{k_2k_\varepsilon I}}{k_1C\sqrt{V}}$ approaches zero, that is, at high concentrations of $FeCl_4^-$ and low light intensities, the above equation reduces to $\gamma = \frac{2k_s}{k_d + k_s}$ With these conditions and also with complete light absorption, the reaction will be of zero order , this is found to be the case Calculation of the quantum yield from the zero-order photoreduction leads to a value of $\frac{k_s}{k_d + k_s}$ of 0 180 At very low concentrations of $FeCl_4^-$ and high light intensities on the other hand, where $\frac{k_1C\sqrt{V}}{\sqrt{k_2k_\varepsilon I}}$ approaches zero, the quantum yield will fall to one half the value of that when reaction 3 is dominant These conditions have never been realized in practice Having evaluated $\frac{2k_s}{k_s + k_d}$ as $\gamma_{max}$, the kinetic equation can be written as

$$\gamma - \frac{\gamma_{max}}{2} = \frac{k_1C}{\sqrt{k_2}}\sqrt{\frac{(\gamma_{max} - \gamma)\,V}{k_\varepsilon I}}$$

Thus a value of $\frac{k_1}{\sqrt{k_2}}$ can be obtained by plotting

$$\frac{\gamma - \frac{\gamma_{max}}{2}}{\sqrt{\frac{(\gamma_{max} - \gamma)V}{k_\varepsilon I}}}$$

against the concentration of $FeCl_4^-$ The value of $\frac{k_1}{\sqrt{k_2}}$ was found to be 0 38 (mol /litre)$^{-1/2}$ sec $^{-1/2}$ at 20° C

An interesting aspect of this work arises in connexion with the reducing properties of the $FeCl_4^{2-}$ complex We have found that in alcoholic solutions it reduces thionine or methylene blue in the dark On slight dilution with water the reaction is reversed and the colour of the thionine returns The reduction of photo-activated thionine by ferrous ion and the dark back-reaction between ferric ion and leuco thionine were studied by Weiss[6] and Rabinowitch[7] Our observations imply a shift in the oxidation-reduction potential of $\frac{FeCl_4^-}{FeCl_4^{2-}}$ compared with $\frac{Fe^{3+}}{Fe^{2+}}$ of at least 0 5 volt, the reversal of the reaction on the addition of water being due to the decomposition of the $FeCl_4^{2-}$ complex Two further points which arise from the photoreduction of $FeCl_4^-$ and the oxidation-reduction potential of $\frac{FeCl_4^-}{FeCl_4^{2-}}$ are (*a*) It is possible to carry out a coupled photosensitized oxidation reduction reaction In the manner described above, the $FeCl_4^-$ complex can be reduced to $FeCl_4^{2-}$ with the accompanying oxidation of the alcohol substrate, the $FeCl_4^{2-}$ ion so formed will then react with thionine or methylene blue reforming the $FeCl_4^-$ and reducing the dye to the leuco form Under suitable conditions the rate of photobleaching of the dyestuff is equivalent to the rate of formation of $FeCl_4^{2-}$ observed in a similar experiment in the absence of the dye

(*b*) By the photoreduction of $FeCl_4^-$, the complex $FeCl_4^{2-}$ can be prepared *in situ* under strict anaerobic conditions From experiments in the absence of the dye one can calculate how much of the ferrous compound is produced under given conditions in a given time When this is compared with the amount actually formed in the presence of thionine together with the amount of thionine bleached, then the equilibrium constant for the system

$$2FeCl_4^{2-} + \text{thionine}^+ \rightleftharpoons 2FeCl_4^- + \text{thionine}^-$$

can be calculated At 20° C and $1\ 05 \times 10^{-2}\ M$ perchloric acid concentration, this equilibrium constant is found to be $2\ 3 \times 10^3$ It is interesting to note that the change in the oxidation-reduction potential produced by this complexing is similar to that produced by cyanide complexing in aqueous solution

The influence of the oxidation-reduction potential in photochemical reactions is well illustrated in this system A detailed account is in the course of preparation

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## Accurate Determination of the Lattice of Beta-Titanium at 900° C.

A unique and original method for determining the high-temperature lattice constant for the body-centred cubic form of titanium was devised by Burger and Jacobs[1] Their method consisted of using a 300-micron wire as a filament in a Lindemann-glass bulb, placing this bulb in the centre of a Debye-Scherrer camera and rotating the bulb while heating the titanium filament to about 900° C The lattice constant arrived at by their original investigation was 3 32 A

In view of the increased purity of titanium available and the improved methods of high-temperature X-ray analysis, we have determined the lattice constant at 900 ± 5° C, with a high degree of precision, using Cohen's[2] method of least squares A 19-cm (Unicam) high-temperature vacuum-type of camera was used in conjunction with a Leeds and Northrup potentiometer for accurate temperature measurements The vacuum within the vacuum chamber was 0 3 of a micron, allowing a minimum of oxide formation on the specimen at this elevated temperature

Titanium used in this determination was supplied by the Remington Arms Corporation, and was reported to be 99 0 + per cent titanium, 0 3 per cent carbon, a few hundredths to a few tenths per cent each of oxygen, nitrogen and iron, and a trace of other elements The nature of the alloying elements and impurities was such as to have little effect on the high-temperature modification, since their atomic diameters would permit of interstitial solid solutions Specimens were prepared by swaging down to 0 050 in and were then annealed at 1,000° C for 1 hr The specimens were placed in cast iron chips and covered with a carbon plug during the annealing Further reductions in size were achieved by grinding on a belt sander

Many attempts were made to obtain a satisfactory X-ray diffraction pattern of titanium using various types of radiation, and a titanium target itself was tried Due to the large radius of the camera and the weakness of the titanium radiation, a satisfactory diffraction pattern was not obtained The three following radiations were used with success cobalt, iron and copper, with the last-named giving the best results of the three

Of the several radiations used, copper gave the highest Bragg angles (more than 60°) and therefore the most accurate data from the point of view of lattice determinations Due to the structure factor of titanium, the X-ray reflexions were weak and the films were difficult to read Exposures were for a duration of 4 hr at 40 kVp and 15 m amp, it was not deemed advisable to expose the specimens longer than this, since the background became denser and the diffraction lines did not increase in intensity proportionately

The data from the exposure using copper radiation were calculated by the method of least squares, and the lattice constant for beta-titanium, body-centred-cubic, at 900° C ± 5° was determined to be $3\ 3065_1 \pm 0\ 00001$ A, and the corresponding atomic diameter is 2 86 A

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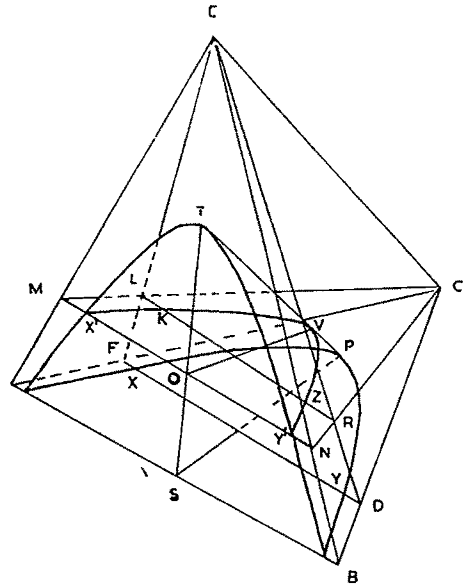
## Quaternary Equilibria Data

In solvent extraction processes involving four liquid components, the interpretation of quaternary equilibria requires extensive data, the experimental determination of which is frequently difficult and laborious It has, however, been shown by Brancker, Hunter and Nash[1,2] that the composition of quaternary phases can be calculated from a knowledge of tie lines in the corresponding ternary systems, and the geometry of a regular tetrahedron

In the accompanying diagram, the equilibria between four liquid components, *E*, *A*, *B*, *C*, are schematically represented on a regular tetrahedron, where $X^1Y^1$ and $XY$ are ternary tie lines situated, respectively, on $MN$ and $FD$ From any point $S$, on



$AB$, perpendiculars are drawn on the planes $EAB$, $CAB$, to cut the equilibrium curves, respectively, at $T$ and $P$ The triangle $TSP$ is constructed where $TSP = 60°$, and $SO$ measured on $ST$ From $O$, a line is drawn at $\angle SOV$ to cut $TP$ at $V$, and $OV$ is measured This construction is repeated for a series of points $S$, $T$, $P$, $O$, and corresponding lengths $O_1V_1$, $O_2V_2$ , measured on $MNC$, defines the quaternary equilibrium curve $X^1VY^1$ The points $L$ and $R$ are then located on $MC$ and $NC$ respectively, and the intersection of $LR$ with $X^1VY^1$ gives the quaternary phases $K$ and $Z$

If the compositions of $M$ and $N$ are known, then, from these and the dimensions of the plane $MNC$, the weight percentages of $E$, $A$, $B$, $C$, present in $K$ and $Z$, can be calculated

Pratt and Glover[3], investigating the extraction of acetone $E$, and acetaldehyde $C$, from vinyl acetate $B$, with water $A$, applied Hunter's[4] method of calculating quaternary data, but reported deviations from the experimental values Employing, however, the simple construction outlined above, the agreement shown in the accompanying table has been found between experimental and calculated data

| Quaternary tie line | (*E*) Experimental (*C*) Calculated | Acetate layer (weight percentages) | | | |
|---|---|---|---|---|---|
| | | Vinyl acetate | Water | Acetone | Acetaldehyde |
| 1 | *E* | 86 9 | 1 4 | 7 1 | 4 6 |
| | *C* | 86 0 | 1 7 | 7 4 | 4 9 |
| 2 | *E* | 81 5 | 1 7 | 12 0 | 4 8 |
| | *C* | 81 2 | 1 8 | 11 9 | 5 1 |
| 4 | *E* | 61 8 | 3 4 | 21 3 | 13 4 |
| | *C* | 61 7 | 3 8 | 21 2 | 13 3 |
| 5 | *E* | 65 8 | 2 8 | 12 3 | 19 1 |
| | *C* | 65 6 | 2 9 | 12 8 | 18 7 |
| 6 | *E* | 83 2 | 1 7 | 6 5 | 8 5 |
| | *C* | 83 3 | 1 8 | 6 4 | 8 5 |
| 7 | *E* | 82 1 | 1 8 | 9 6 | 6 5 |
| | *C* | 82 0 | 1 9 | 9 8 | 6 3 |
| | | Water layer | | | |
| 1 | *E* | 2 3 | 88 3 | 4 7 | 4 7 |
| | *C* | 2 6 | 88 0 | 4 5 | 4 9 |
| 2 | *E* | 3 1 | 84 4 | 8 0 | 4 5 |
| | *C* | 3 0 | 84 0 | 8 2 | 4 8 |
| 4 | *E* | 4 7 | 70 2 | 13 4 | 11 7 |
| | *C* | 4 8 | 70 3 | 12 9 | 12 0 |
| 5 | *E* | 4 0 | 72 8 | 7 4 | 15 8 |
| | *C* | 3 5 | 73 1 | 7 7 | 15 7 |
| 6 | *E* | 2 8 | 83 8 | 4 1 | 9 3 |
| | *C* | 2 5 | 84 2 | 4 1 | 9 2 |
| 7 | *E* | 2 7 | 85 0 | 7 4 | 4 9 |
| | *C* | 2 6 | 84 8 | 7 6 | 5 0 |

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## A Spectroscopic Determination of the Shift of the 3S Term in Hydrogen

IN a recent publication[1], the resolution and measurement of the satellite $2S_{1/2}$–$3P_{1/2}$ in the fine structure of the first member of the Balmer series in heavy hydrogen was reported The much weaker satellite $2P_{3/2}$–$3S_{1/2}$ has now been resolved by the use of a double Fabry–Perot etalon with appropriate spacers The light source was a U-tube cooled in liquid hydrogen, similar to that described by Kuhn and Series[1] The weak satellite was found to be at a distance 0 133 ± 0 001 cm$^{-1}$ from the peak of the complex ($2P_{3/2}$–$3D_{5/2}$, $3D_{3/2}$), which is to be compared with the distance 0 141 cm$^{-1}$ predicted by the Dirac theory, a figure which includes the small corrections explained in the earlier communication[1] General arguments[1] indicate that the discrepancy is to be attributed to the position of the $3S$ term, which is therefore raised 0 008 ± 0 002 cm$^{-1}$ above the level predicted by the Dirac theory

The $3S$ term is thus shifted by an amount which appears to be rather less than the value 0 0104 cm$^{-1}$ predicted by the radiation theory of Bethe and others[2] A difference in the same sense has been found for the $3S$ term in ionized helium by Hirschberg and Mack[3] and by Kopfermann *et al* [4] On the other hand, Lamb and Skinner[5] have found the $2S$ term in ionized helium to be shifted more than the radiation theory predicts, and Lamb and Retherford[6] and Kuhn and Series[1] have found that the $2S$ term in hydrogen is slightly above its predicted position

The experimental details of the new measurement will be reported more fully elsewhere I wish to acknowledge many helpful discussions with Dr H Kuhn

G W SERIES

Clarendon Laboratory,
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July 24

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[1] Kuhn, H , and Series, G W , *Proc Roy Soc* , A, **202**, 127 (1950)

[2] Bethe, H A , Brown, L M , and Stehn, J R , *Phys Rev* , **77**, 370 (1950)

[3] Hirschberg, J G , and Mack, J E , *Phys Rev* , **77**, 745 (1950)

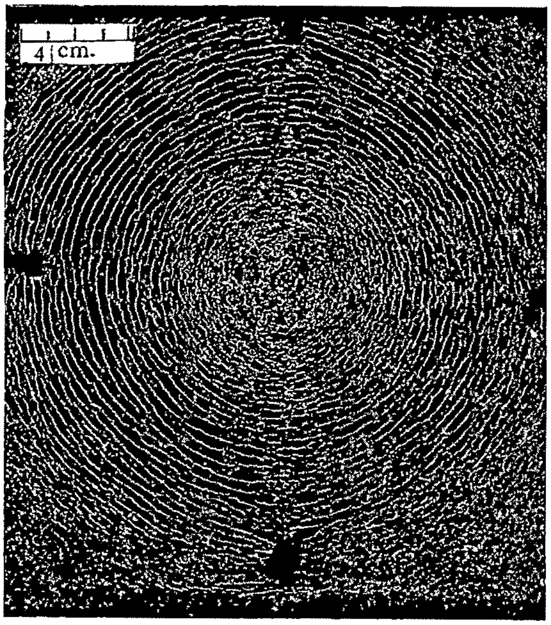
[4] Kopfermann, H , Kruger, H , and Öhlmann, H , *Z Phys* , **126**, 760 (1949)

[5] Lamb, W E , and Skinner, M , *Phys Rev* , **78**, 539 (1950)

[6] Lamb, W E , and Retherford, R C , *Phys Rev* , **75**, 1325 (1949)

## New Method of Forming Powder Striations

I NOTICED, while experimenting with a vibrating Chladni plate, that striations had made their appearance on some sand which had inadvertently been spilled on the bench below The plate, at the time, was supported horizontally on some rubber studs which left an air space of only a few millimetres



between it and the bench That the striations were not caused by vibrations of the latter was easily proved by supporting the plate independently from above, and then producing the striations on a second stationary plate, or drawing board, which rested on a 'Sorbo' mat

The striations, shown in the accompanying illustration, are typical of the sort of effect which can be produced by using a circular or square plate vibrating in the lowest mode in which the centre is antinodal The scale of 4 cm attached to the record shows that the order of separation between the striations is 3 mm This, in different circumstances, can be varied from about 2 mm to 8 mm This happens also to be the approximate range over which the air space can be altered The vibration frequency used in producing this record, using a square brass plate of dimensions 20 3 cm × 20 3 cm. × 0 48 cm , was 507 c /sec At a lower frequency the distance between the striations was greater, which was also the case with wider air gaps When the amount of sand or other graded powder is suitable, the particles align themselves, so that under magnification they present the appearance of a single threaded string of beads

It seems probable that the way the striations are formed is the same as for the Kundt striations Andrade[1], in the second of his well-known papers on the Kundt tube, has shown that the oscillatory motion of the air sets up vortex motions around individual particles which are the cause of the striations It is significant that the distances between the striations produced, either by a Kundt tube or by a Chladni plate, are of the same order The fact that they are very easily made using graded cork powder, so light that it disappears if blown upon, supports the conclusion that the mechanism depends upon vortex air motions rather than on any 'saltation'[2], or bouncing, of the heavier and more elastic sand particles

Further investigations on this new and interesting phenomenon are now in progress These, it is anticipated, will include putting obstacles of various shape and size in the path of the striations, a procedure which is suggested by the appearance of the striations around the left hand of the rather large four supporting rubber pads the positions of which are evident in the illustration

MARY D WALLER

5 Gloucester Gate,
London, N W 1
Aug 14

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[1] Andrade, *Phil Trans*, 230, 413 (1932)

[2] Bagnold, "The Physics of Blown Sands and Desert Dunes" (1941)

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## Thermodynamic Equilibrium

IN a previous communication[1] under this heading, an error of sign occurred resulting from an imperfect analysis of the ways in which a physico-chemical system in reversible equilibrium may do virtual work In order to rectify this error and to clarify the subject generally, a more satisfactory discussion is here given

All the forces by which a system does work are internal forces in the sense that they are part of the system and not of its surroundings They are, however, of two thermodynamically distinct kinds

(*a*) Externally operating forces ($X_e$) which do work against the surroundings, resulting in a loss $\Sigma X_e \, dx_e$ of energy by the system to the surroundings, and

(*b*) Internally operating forces ($X_i$). When these operate, particles within the system move to positions of lower potential energy, resulting in a loss $\Sigma X_i \, dx_i$ of potential energy in the fields of these forces This energy, however, does not leave the system but is transformed into chemical energy, which is increased by the amount $\Sigma\mu \, dn$ thereby for a closed system

The general chemical condition of equilibrium

$$\Sigma\mu \, dn = \Sigma X_i \, dx_i$$

therefore simply describes a state of balance such that for any possible virtual change of the system the work done against the chemical forces or the increase of chemical energy equals the work done *by* the internally operating forces and not against them as was previously stated in error The general chemical condition of equilibrium may also be written $\Delta\mu = W_i$ when considering gram-molecular changes, and here $W_i$ must also be interpreted as the work done by the internally operating forces

It may be helpful also to add a short explanation of the relation between $\Delta\mu$ and $\Delta G_{T,P}$, the change of Gibbs free energy at constant temperature and pressure This is important because $-\Delta G_{T,P}$ may always be identified with the net (maximum) external work done by the system under atmospheric conditions It follows that $\Delta G_{T,P}$ and $\Delta\mu$ are equal whenever the net external work is equal and opposite to $W_i$ This is the case for the overall changes in many electrochemical cells when balanced against a potentiometer, and also, of course, whenever $W_i$ and the net external work are both zero However, in general, there is no simple relation between $\Delta\mu$ and $\Delta G_{T,P}$ Thus, for example, there are many important practical cases where $\Delta G_{T,P}$ is equal to zero but where internally operating forces are present at boundaries or elsewhere with the result that $\Delta\mu$ does not vanish.

G A ELLIOTT

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Oct 15

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[1] *Nature*, 165, 934 (1950)

# FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

## Monday, December 4

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 5 p m —Mr A T Grove "Erosion and Population Problems in the Eastern Provinces, Nigeria"

University of London (at King's College, Strand, London, W C 2), at 5 30 p m —Dr Armando Cortesao "The Contribution of the Portuguese to Scientific Navigation and Cartography" *

Royal Meteorological Society (at the Royal Institution, 21 Albemarle Street, London, W 1), at 6 p m —Sir Robert Watson-Watt, F R S "Wireless in Weather Watching" (Meeting open to Sixth Form Students )

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 15 p m —Sir Harry Ricardo, F R S "The Sleeve-Valve Diesel Engine" (Andrew Laing Lecture)

Pharmaceutical Society (at 17 Bloomsbury Square, London, W C 1), at 7 30 p m —Dr J Carmichael "Veterinary Therapeutics"

## Tuesday, December 5

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W 1), at 2 30 p m —Dr Ronald Bradbury "The Modern House in 1850 and 1950—a Parallel and a Contrast" (Bossom Gift Lecture) *

Royal Anthropological Institute (at 21 Bedford Square, London, W C 1), at 5 p m —Dr T T Paterson "A Kinship System in Scotland"

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr J M Coulson and Mr J H Ellinger "A Nomograph for the Calculation of Heat Transfer Coefficients for Convection without Change of Phase", Mr H R C Pratt "The Application of Turbulent Flow Theory to Transfer Processes in Tubes containing Turbulence Promoters and Packings"

Manchester Geographical Society (in the Geographical Hall, 16 St Mary's Parsonage, Manchester), at 6 30 p m —Dr T Ifor Rees "Glimpses of Bolivia and Peru"

Sheffield Metallurgical Society (at the Grand Hotel, Sheffield), at 7 p m —Mr P M Cook "Photo Elastic Stress Analysis"

Textile Institute, Yorkshire Section (joint meeting with the Bradford Textile Society, at the Midland Hotel, Bradford), at 7 p m —Mr W L Thomas "Production and Testing of Wool Tops from the Chemist's Standpoint"

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7 30 p m —Mr J R Boundy and Mr S G Bergen "An Electronic Process Controller"

## Wednesday, December 6

Physical Society, Colour Group (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 3 30 p m —Mr F L Warburton "Variations in Normal Colour Vision in relation to Practical Colour Matching"

Physical Society, Low Temperature Group (at the Science Museum, Exhibition Road, London, S W 7), at 5 p m —Annual General Meeting, at 5 30 p m —Papers on "Low Temperature Expansion Engines"

British Museum (Natural History) (in the Huxley Lecture Theatre, Imperial College of Science and Technology, Exhibition Road, London, S W 7), at 5 30 p m —Dr R M Craig "The Pleistocene Glaciation in Great Britain and its Effects" (Swiney Lectures) * (Further Lectures on December 8, 11, 13, 15, 18, January 3, 5, 8, 10, 12 and 15 )

Institute of Petroleum (at Manson House, 26 Portland Place, London, W 1), at 5 30 p m —Spectroscopic Panel of the I P Hydrocarbon Research Group Symposium on "Absorption Spectroscopy in the Petroleum Industry"

Institute of Rural Life at Home and Overseas (in Room 013, Sanctuary Buildings, Great Smith Street, London, S W 1), at 5 30 p m —Mr Fergus Wilson "Some Aspects of Planning and Development amongst African Peasant Communities"

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London W C 2), at 5 30 p m —Mr R W Douglas and Dr E G James "Crystal Diodes", Mr T R Scott "Crystal Triodes"

Institute of Welding, Manchester and District Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p m —Mr A V Houston "Distortion in the Welding of Mild Steel"

Society of Public Analysts and other Analytical Chemists (joint meeting with the Food Group of the Society of Chemical Industry, at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 8 15 p m —Mr H C S de Whalley, Mr N Albon and Dr D Gross "Applications of Paper Chromatographic Methods in the Sugar Industry"

## Thursday, December 7

British Glaciological Society (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Symposium on "The Crystallisation of Metals, Rocks and Ice"

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Mr A C H Frost and Mr W Brittlebank "The Control of Hydro-Electric Plant"

B[illegible] Radio Engineers, North-Western [illegible] Manchester), at 6 45 p m — [illegible]ion"

British Institution of Radio Engineers, Scottish Section (at the Heriot Watt College, Edinburgh), at 6 45 p m —Mr D Latham "Vacuum Engineering applied to Electronics"

## Friday, December 8

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 2 p m —Dr R R Goodall "Partition Chromatography"

Chemical Society, Birmingham Section (joint meeting with the University Chemical Society, in the Chemistry Department, The University, Edgbaston, Birmingham) at 4 30 p m —Prof D H Hey "Homolytic Aromatic Substitution"

Royal Astronomical Society (at Burlington House, Piccadilly, London, W 1), at 4 30 p m —Scientific Papers

Chemical Society, Newcastle and Durham Section (in the Chemistry Building, King's College, Newcastle-upon-Tyne), at 5 p m —Prof H J Emeléus, F R S "The Application of Halogen Fluorides in Preparative Inorganic Chemistry" (Bedson Club Lecture) (All Fellows are invited )

Chemical Society, Hull Section (joint meeting with University College Scientific Society, in the Science Lecture Theatre, University College, Hull), at 6 p m —Prof John Read, F R S "Chemical Personalities a Century Ago"

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W C 2), at 6 p m —Discussion on "How Best to Introduce the *ab initio* Use of the M K S System to Students" (to be opened by Dr F T Chapman)

Society of Glass Technology, North-West Section (at the Gas Showrooms, Radiant House, St Helens), at 6 30 p m —Dr A T Green "Refractories"

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 7 p m —Sir Charles Ellis, F R S "The Structure of Coal"

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W C 2), at 7 p m —Dr W J Arrol "The Preparation of Radio-active Materials in a High Degree of Purity"

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p m —Prof E N da C Andrade, F R S "High Vacuum"

## Friday, December 8—Saturday, December 9

Physical Society (in the Maxwell Lecture Theatre, Cavendish Laboratory, Cambridge) —Autumn Provincial Meeting

### Friday, December 8

At 5 p m —Dr A S Russell Fifth Rutherford Lecture

## Saturday, December 9

British Trust for Ornithology (joint meeting with the Lincs Naturalists Union and Naturalists Trust, in the Technical College, Lincoln), at 2 15 p m —Mr Bruce Campbell "The Work of the British Trust for Ornithology"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Experimental Officer in the Agricultural Research Council organization concerned with insecticide and fungicide research and development problems—The Secretary, Inter-Departmental Insecticide Committee, 43 Draycott Place, London, S W 3 (December 9)

Head (male) of Poultry Department at Loughry Agricultural College (for girls), Cookstown, Co Tyrone—The Establishment Officer, Ministry of Agriculture, Stormont, Belfast (December 9)

Lecturer in Mathematics—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (December 9)

Assistant Lecturer in the Department of Pharmaceutics, and an Assistant Lecturer in the Department of Pharmacognosy —The Secretary, School of Pharmacy (University of London), 17 Bloomsbury Square, London, W C 1 (December 10)

Assistant Inspector (Forestry) in the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast (December 11)

Bacteriologist for work in biological laboratories, which will be mainly concerned with fundamental aspects of brewing microbiology —The Director, Brewing Industry Research Foundation, 40 Sackville Street, London, W 1 (December 11)

General Assistant Engineer (Mathematical Assistant) in the Electro-Technical Research Section at headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W 1, quoting Ref AE 116 (December 11)

Assistant to the Head of the Biological and Agricultural Section of the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting No G 296/50A (December 16)

Senior Lecturer or Lecturer in Physics, and a Lecturer in Physical Geography, at the University of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 16)

Principal Scientific Officers (with first- or second-class honours degree in a science subject, engineering or mathematics) in the Intelligence Division of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W 1, quoting No 3377 (December 22)

HEAD OF THE APPLIED SCIENCE DEPARTMENT in the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton

HONOURS GRADUATE IN ENGINEERING with, if possible, some practical experience in electronics, or PHYSICIST with some practical knowledge of spectroscopy—The Director, British Electrical and Allied Industries Research Association, 5 Wadsworth Road, Greenford, Middx

PHYSIOLOGIST at the M R C Climatic and Working Efficiency Unit—Prof W E Le Gros Clark, F R S , Department of Human Anatomy, University Museum, Oxford

SENIOR AGRICULTURAL ECONOMIST (with a degree in agriculture or economics, and considerable experience of investigational work)—The Registrar, Wye College, Wye, Ashford, Kent

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

British Council Report for the Year 1949–1950 Pp v+128 (London British Council, 1950 ) [199

Bulletin of the British Museum (Natural History) Mineralogy, Vol 1, No 2 Volcanic Rocks from the Cape Verde Islands By Gerald M Part Pp 25–72 10*s* Zoology, Vol 1, No 4 Notes on Asteroids in the British Museum (Natural History), by D Dilwyn John , *Lernaeodiscus pusillus* nov spec , a Rhizocephalan Parasite of *Porcellana* from Egypt, by H Boschma Pp 51–66 4*s* Geology, Vol 1, No 4 A New Tithonian Ammonoid Fauna from Kurdistan, Northern Iraq By L F Spath Pp 93–146+plates 6–10 10*s* (London British Museum (Natural History), 1950 ) [199

Philosophical Transactions of the Royal Society Series A Mathematical and Physical Sciences No 854, Vol 242 The Propagation of Sound Pulse in the presence of a Semi-Infinite Open-ended Channel, 1 By W Chester Pp 527–556 7*s* 6*d* No 855, Vol 242 The Theory of Axisymmetric Turbulence By S Chandrasekhar Pp 557–578 4*s* 6*d* (London Cambridge University Press, 1950 ) [199

National Institute of Economic and Social Research Annual Report, 1949–50 Pp 32 (London National Institute of Economic and Social Research, 1950 ) [199

Air Ministry Meteorological Office Geophysical Memoirs No 86 Solar Radiation at Kew Observatory By Dr J M Stagg (M O 530a ) Pp 37 3*s* 6*d* net Meteorological Reports No 7 Equivalent Headwinds on some of the Principal Air Routes of the World (M O 535b ) Pp ii+19 9*d* net (London H M Stationery Office, 1950 ) [199

Library Association Pamphlet No 1 Books and Reading for the Blind By Robert S Clark Pp iii+40 (12 plates ) 4*s* , 3*s* 6*d* to members Pamphlet No 2 The Regional Library Systems By P H Sewell Pp iii+36 3*s* , 2*s* 6*d* to members (London Library Association, 1950 ) [199

Air Ministry Meteorological Office Geophysical Memoirs No 85 Upper Winds over the World By Dr C E P Brooks, C S Durst, N Carruthers, D Dewar and J S Sawyer (M O 499e ) Pp ii+150 (London H M Stationery Office, 1950 ) 17*s* 6*d* net [209

Ministry of Fuel and Power Benzole and Toluene from Coal Gas Report on Technical Work carried out between 1941 and 1945 Pp 74+23 Tables (London H M Stationery Office, 1950 ) 5*s* 6*d* net [209

Philosophical Transactions of the Royal Society Series B Biological Sciences No 616, Vol 234 Some Quantitative Dental Characteristics of the Chimpanzee, Gorilla and Orang-Outang By E H Ashton and S Zuckerman Pp 471–484 5*s* No 617, Vol 234 Some Quantitative Dental Characters of Fossil Anthropoids By E H Ashton and S Zuckerman Pp 485–520 9*s* (London Cambridge University Press, 1950 ) [209

Question (Published for the Present Question Conference ) Vol 3, No 1 People at Work By Dr J H Oldham, H Westmann, John A Mack and Sir Wilfrid Garrett Pp 91 (London Hammond, Hammond and Co , Ltd , 1950 ) 2*s* 6*d* [209

## Other Countries

World Health Organization Technical Report Series No 17 Joint OIHP/WHO Study-Group on Bilharziasis in Africa , Report on the First Session Pp 16 (Geneva World Health Organization , London H M Stationery Office, 1950 ) 9*d* , 10 cents [248

Ochrona Przyrody Rocznik 19 Pp xii+212 (Kraków Panstwowa Rada Ochrony Przyrody, 1950 ) [248

Conseil International des Unions Scientifiques Union Géodésique et Géophysique Internationale, Association de Seismologie Publications du Bureau Central Seismologique International, Série A Travaux scientifiques, Fasc 17, Communications présentées à la Conférence d'Oslo (Août 1948 ) Pp 254 (Toulouse Édouard Privat et Cie , 1950 ) [149

Report of the Committee on the Protection of Building Timbers in South Africa against Termites, Wood-boring Beetles and Fungi Pp xiv+218 (Pretoria National Building Research Institute, 1950 ) [149

Bericht uber das Geobotanische Forschungsinstitut Rübel in Zurich fur das Jahr 1949 Von E Rubel und W Ludi Pp 117 (Zurich Geobotanische Forschungsinstitut Rubel, 1950 ) [199

Indian Council of Agricultural Research Miscellaneous Bulletin No 69 Estate Farming in India , a Study in Large-scale Agricultural Enterprises in India Pp iv+99+37 plates (Delhi Manager of Publications, 1948 ) 2 4 rupees , 3*s* 9*d* [199

East African Agriculture and Forestry Research Organisation Annual Report, 1949 Pp 44 (Nairobi East African Agriculture and Forestry Research Organisation, 1950 ) 2*s* 6*d* [199

Commonwealth Scientific and Industrial Research Organization Bulletin No 244 Wheat in a Victorian Bulk Depot By F. Wilson Pp vi+47 (Melbourne Government Printer, 1949 ) [199

Queensland Institute of Medical Research Fourth Annual Report, Year ended 30th June 1949 Pp 16 (Brisbane Queensland Institute of Medical Research, 1950 ) [199

B A N Z Antarctic Research Expedition, 1929–1931 Reports, Series B (Zoology and Botany) Vol 4, Part 10 Echinoidea By Th Mortensen Pp 287–310+plates 4–9 8*s* Vol 5, Part 6 Foraminifera By Walter J Parr Pp 233-392+plates 3–15 40*s* (Adelaide Barr Smith Library, The University, 1950 ) [199

United Nations Annual Report of the Secretary-General on the Work of the Organization, 1 July 1949–30th June 1950 Pp xiv+143 (Lake Success, N Y United Nations , London H M Stationery Office, 1950 ) 11*s*. [199

The Fukui Earthquake of June 28, 1948 Report of the Special Committee for the Study of the Fukui Earthquake Edited by H Tsuva Pp vii+197+6 plates. (Tokyo Earthquake Research Institute, 1950 ) [199

The Matrilineal Social Organisation of the Nagas of Assam a Study from the Sociological Point of View By Dr K M Kapadia Pp iv+34 (Bombay Popular Book Depot, 1950 ) 1 rupee [199

Indian Forest Bulletin No 147 Indian Woods for Battery Separators By M A Rehman and Jai Kishen Pp iii+16 (Delhi Manager of Publications 1950 ) 9 annas , 10*d* [199

Instituto Brasiliero de Geografia e Estatistica Conselho Nacional de Geografia Contribuicao ao Estudo do Clima do Rio Grande do Sul Por Floriano Peixoto Machado Pp vii+91 (Rio de Janeiro Instituto Brasiliero de Geografia e Estatistica, 1950 ) [199

University of Illinois Engineering Experiment Station Bulletin No 384 Fatigue Strength of various Types of Butt Welds connecting Steel Plates By Wilbur M Wilson, William H Munse and I Sterling Snyder Pp 58 50 cents Bulletin No 385 Moments in Two-Way Concrete Floor Slabs By Chester P Siess and Nathan M Newmark Pp 192 60 cents Bulletin No 386 Studies of Highway Skew Slab-Bridges with Curbs, Part 2, Laboratory Research By Myron L Gossard, Chester P Siess, Nathan M Newmark and Lawrence E Goodman Pp 79 45 cents (Urbana, Ill University of Illinois Engineering Experiment Station, 1950 ) [199

University of Illinois Engineering Experiment Station Circular No 59 Input Impedance of a Slotted Cylinder Antenna By Charles A Holt Pp 50 40 cents Circular No 60 Lectures on Foundation Engineering By A E Cummings Pp 142 1 dollar (Urbana, Ill University of Illinois Engineering Experiment Station, 1949–1950 ) [199

Bulletin of the Museum of Comparative Zoology at Harvard College Vol 104 The Ants of North America By William Steel Creighton Pp 585+57 plates (Cambridge, Mass Harvard College, 1950 ) [199

Memoirs of the Geological Survey of India Palæontologia Indica, New Series, Vol 22, Memoir No 7 The Carboniferous and Permian Faunas of South Iran and Iranian Baluchistan By Dr J A Douglas Pp vii+57+5 plates (Delhi Manager of Publications, 1950 ) 9 4 rupees , 14*s* 6*d* [209

A G Series Geological Maps By L V Agashe and R B Gupte Pp ii+24 maps (Poona L V Agashe, 582 Shanwar Peth, 1950 ) 2 4 rupees [209

Report of the King Institute of Preventive Medicine, Guindy, for the Period from 1st April 1948 to 31st March 1949, by Dr K V Venkatraman , and Report of the Government Analyst, Madras, by K V Sundaram Ayyar Pp 90+4 (Madras Government Press, 1950 ) 1 12 rupees [209

United States Department of Agriculture Guide to the Literature on Collagen By Rubin Borasky Pp iv+135 (Philadelphia Eastern Regional Research Laboratory 1950 ) Free [209

Svenska Linné-Sällskapets Årsskrift Årgång 32, 1949 Pp 130 (Uppsala Almquist and Wiksells, 1950 ) [209

American Institute of Crop Ecology International Agro-Climatological Series Study No 10 Ecological Crop Geography of Finland and its Agro-Climatic Analogues in North America By M Y Nuttonson Pp 35 Study No 11 Agricultural Climatology of Sweden and its Agro-Climatic Analogues in North America By M Y Nuttonson Pp 27 Study No 12 Ecological Crop Geography of Norway and its Agro-Climatic Analogues in North America By M Y Nuttonson Pp 32 (Washington, D C American Institute of Crop Ecology, 1950 ) [209

United States Department of the Interior Geological Survey Professional Paper 216 Structural Geology of the Hawthorne and Tonopah Quadrangles, Nevada By Henry G Ferguson and Siemon W Muller Pp v+55+15 plates 2 dollars Professional Paper 219 Geology and Ore Deposits of the La Plata District, Colorado By Edwin B Eckel, with Sections by J S Williams, F W Galbraith and others Pp vii+179+29 plates 2 50 dollars Professional Paper 227 Pegmatite Investigations in Colorado, Wyoming and Utah, 1942–1944 By John B Hanley, E Wm Heinrich and Lincoln R Page Pp vi+125+17 plates 1 50 dollars (Washington, D C Government Printing Office, 1949–1950 ) [209

## Catalogues

Books on Naval History, Ships and Shipping Naval Architecture Ship Models, Yachting, etc , also Topography and Local History of England (Catalogue 706 ) Pp 102 (London Francis Edwards Ltd , 1950 )

TMC Technical Journal Vol 1, No 2, September Pp 32 (London Telephone Manufacturing Co , Ltd , 1950 )

Rohm and Haas Reporter Vol 8, No 2, April–May Pp 26 Vol 8, No 3, June-July Pp 22 (Philadelphia Rohm and Haas Company, 1950 )

Tinsley Single Unit Ink Recording Polarograph Pp 4 (London Tinsley (Industrial Instruments), Ltd , 1950 )

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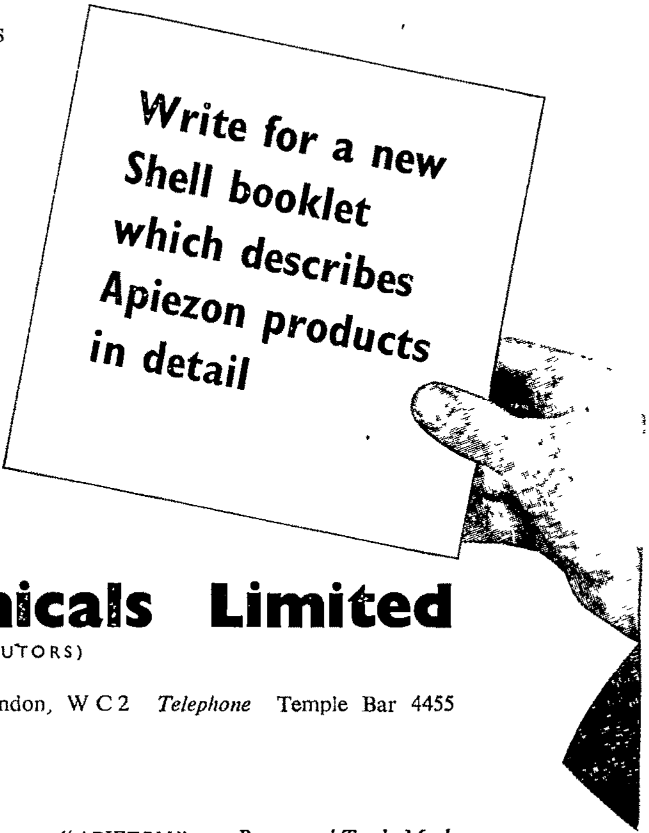

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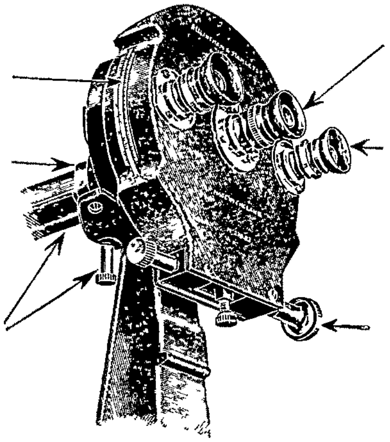

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# NATURE

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# SCIENTIFIC RESEARCH AND INDUSTRY IN GREAT BRITAIN

THE report from the Department of Scientific and Industrial Research for the year 1948–49 (see p 971 of this issue) is on the lines of the reports issued annually in the decade or more before the War, and the summary of work which occupies the bulk of the report goes far to meet the criticism of the Select Committee on Estimates three years ago, and more recently of the Committee of Public Accounts, regarding the need for greater detail This is particularly true with regard to the research associations, and it can fairly be claimed in respect of the present report that sufficiently detailed information is supplied to facilitate independent judgment as to the value to the nation of the work alike of the research associations and the establishments of the Department, and the return obtained from the expenditure of more than three millions from the national exchequer Moreover, the report of the Advisory Council, with its discussion of broad questions of policy, should inspire every confidence that the expenditure is being directed to the right objectives, and that the Council should be able to count on the full support, not only of the Advisory Council on Scientific Policy, but also of scientific men and industrialists in Britain generally

In the present report, the Advisory Council is especially concerned with two aspects of general policy The first is that of the choice of problems; attention was directed to this matter in last year's report Here the Council's first concern is how best the available resources of the Department can be used for the solution of current national problems. Conferences of the chairmen and directors of the research associations and of the chairmen of the advisory boards held early in the year provide ample evidence of the value of the work which is being done both by the establishments and the research associations within the limits of their present resources, and of the increasing extent to which government departments and industry are turning to them for the solution of technical problems Nevertheless, it is essential in these critical times that the tasks for which available resources are used should be, not merely useful, but also the most useful that can be undertaken for restoring the prosperity of Great Britain Further, the Advisory Council insists that it is no less essential to ensure that every practicable step is taken, once a piece of work is finished, to apply the results in practice

The Advisory Council has here seized the real core of criticism that has been advanced from outside of the work of the boards and of the research associations, and that it has done so should of itself dispose such critics to consider, in the light of the fuller details now disclosed, that the selection of problems is wisely made and in full touch with the particular industries being served Moreover, so far as certain broad national needs are concerned, it is difficult to conceive of an alternative form of organization to which the choice of problems could more appropriately be entrusted

For the Department's establishments, the Advisory Council points out, the choice of problems is made primarily on the advice of their respective boards, and the Council is convinced that in general the choice of problems is wisely made It is difficult, however, with so many problems of admitted importance brought to the notice of the Department, to keep programmes within such limits as will ensure an adequate effort being devoted to each problem that is accepted It is essential, the Advisory Council insists, to be constantly on guard against undue dissipation of scientific effort

Secondly, in this connexion, the Advisory Council refers once more to the need for more basic research For ten years—during the War and since—basic research has had to be largely suspended, yet it is only on the foundation of such work that the Department's establishments can maintain, let alone increase, their ability to give the technical advice that must continue to be in such demand In some fields, such as mechanical engineering, the Department has indeed given encouragement and financial support to new researches at universities, as at Cambridge, Edinburgh, Sheffield, Leeds, Bristol, Manchester and the Imperial College of Science and Technology and Queen Mary College, London, but apart from the natural limits to such extra-mural work, it can be no substitute for fundamental work at the Department's own stations In current circumstances, however, the Advisory Council recognizes that a proper balance between short-term and basic work can be restored only as new staff becomes available, but it notes some improvement in recruitment during the year and a consequent limited resumption of basic work

As regards the research associations, the choice of problem rests with their councils, including both industrialists and scientific men, as well as representatives of the Department and other government departments concerned among their members, and the Advisory Council considers that the programmes undoubtedly represent the best opinion in the various industries on the problems the solution of which can most powerfully assist their progress That opinion might perhaps be subject to the qualification that the membership of the research association is fully representative of the industry it serves At the same time, the Advisory Council has found some difference of opinion as to how far research associations should engage on outside laboratory research on materials and processes

In the Council's own view, the research associations must be at liberty to take responsibility for investigations, including economic and sociological studies, in any field of science Putting it even more generally than in last year's report, it is suggested that the research associations may, either directly or indirectly through related bodies, provide for their industries a scientific service bearing on all aspects of production that their councils may determine, including, it may be, works organization Work of this wider nature may indeed require a type of staff difficult to find in Great Britain, and the Advisory Council fully realizes that the new ground which the research associations may be expected to cover cannot at present be large Nevertheless, it considers that the linking of physical scienc and engineering with economic studies within industr holds much promise for the future, and that th training of suitable staff is a matter of importanc at the present time Manifestly, if such work i to be done at all, it must be done by co-operativ effort of the type represented by the researc associations

The other main reference to the work of th research associations in the present report is i connexion with the second of the principal problem giving particular concern to the Advisory Counci namely, that of securing the quickest and fullest us of the results of research The Advisory Counc recognizes frankly that this is a complex and difficul problem, and that it is by no means as easy t ensure that the results of research conducted outsid a firm's own laboratories, either in a governmen establishment or in a research association, ar brought within the main stream of industrial activit as it is to secure the application of the results research undertaken by an industrial firm in its ow laboratory This is, of course, the main reason wh some industrialists believe there are limits in practic to the effectiveness of co-operative industrial researc in comparison with that of individual firms Th Advisory Council seems now to be fully aware this difficulty, for while giving the closest attentio to the best means of avoiding the risk that valuabl results may be left high and dry in the laboratory, points out that, as the services rendered by th establishments and the research associations ar extended, the development of initiative by th individual firms must not thereby be discourage It is already giving close attention to one or tw instances where it is not wholly satisfied that industr is being required to do all that it could

The question how far an establishment of th Department or a research association should carr its laboratory work into the development stage doe not, the Advisory Council points out, admit of uniform answer, in its view, where the question large-scale or pilot-plant trial arises, each propos must be judged on its merits Some of the faciliti for full-scale tests at the Department's establishment as at the Building Research Station or the Roa Research Laboratory, or the experimental hold the Ditton Laboratory for studies of the control temperature and other conditions in refrigerate cargo-spaces carrying foodstuffs, are well know Many research associations, too, have equipped themselves with large-scale facilities for special purpose The Launderers' Research Association, for exampl has an experimental laundry capable of permittin the investigation of production problems, an facilities are available in the laboratories of th Printing Research Association for carrying out a normal printing operations The Motor Researc Association is equipping a disused airfield as proving ground for performance tests on vehicle The textile research associations have fully equippe spinning and weaving sheds, opening and cardin rooms, where new machinery and processes can b tried out under conditions closely approximating to those of the mill; and the metal and engineering research associations are equipped for conducting full-scale investigations on furnaces, rolling-mills, foundries, gas and steam turbines and the like.

Undoubtedly, however, the determining factor in the use of science by industry is, as the Advisory Council suggests, the desire and capacity of the individual firm to apply its results, and as Sir Andrew McCance has stated, "in many of the cases where the collaboration between industries and the Association has not been so successful, it has arisen because there was an insufficient density of technically trained people in positions of control and authority". This is the cause of many of the most perplexing problems facing the Department of Scientific and Industrial Research, and although small size of a firm is not necessarily incompatible with the effective exploitation of discoveries, sometimes it is itself a symptom of the lack of scientific and technical staff rather than the cause of it. Moreover, while the work of most small firms does not call for the development of scientific discoveries, the fact that in most industries firms are at very different levels technically makes it difficult to strike the right balance in providing for the needs of both the technically advanced and those which are technically weak.

Despite all these difficulties, however, the Advisory Council is satisfied that the establishments of the Department and the research associations have a high level of achievement, and that in various ways the use of science by industry can be further promoted. As the employment of scientific men and technologists in industry spreads, much knowledge that at present has to be pushed into industry from the outside will be pulled in from the inside, with increased probability of effective use and at an earlier stage. Nevertheless, the Advisory Council is seeking more effective information on certain questions. Are firms getting the right type of science graduate? Are research reports reaching them in effective form? Do firms that are unable to maintain a research department of their own need special facilities for developing their individual ideas over and above those that can be provided by research associations? To this end, it has recommended a grant to the Manchester Joint Research Council to assist a special survey of the use of science by firms in the north-west of Britain and of the extent to which their scientific needs are being met. The Advisory Council also continues to emphasize the importance of generous encouragement of selected researches at the universities, and of adequate provision of training for young research workers.

From what has been said here, and in the article on p. 971 surveying the work of the Department of Scientific and Industrial Research, it is manifest that the various changes of personnel to which the report refers have in no way affected the continuity of policy pursued by the Council. The present report shows admirably its grasp of the principles which should determine the work of the Department, and the promotion of the utilization of science in industry.

# JOSEPH HENRY: A GREAT AMERICAN

## Joseph Henry, his Life and Work

By Thomas Coulson. Pp. ix+352+7 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1950.) 32*s*. 6*d*. net.

THE name of Joseph Henry is known and honoured in Great Britain for his discoveries in electromagnetism, made simultaneously with those of Faraday, and his administration of the Smithsonian Institution of Washington from the time of its foundation; but very little has been written about Henry for those who wish to know more than the bare facts, and British readers, as no doubt American, are greatly indebted to Mr. T. Coulson for this excellent account of the life and work of one of the most important figures in the history of American science.

The comparison between Henry and Faraday is inevitable, not only because they worked at the same time in the same scientific field, but also because there are close similarities in their lives. Both were of humble origin and largely self-educated; both were men of strong religious convictions who yet found no difficulty, as some of their contemporaries did, in reconciling their science with their religion; and both devoted themselves, in their researches, to increasing the sum of human knowledge, leaving the application and the pecuniary gain to others.

There has been much discussion of priorities between the two. Mr. Coulson reproaches Faraday for not mentioning Henry in his early papers on electromagnetism, particularly in connexion with the ring electromagnet with which Faraday made his original discovery of the induction of electric currents on August 29, 1831; but there is really no evidence, it seems to me, that he derived the idea from Henry, or that he was even aware, at the time, of Henry's researches and improvements on Sturgeon's electromagnet. Henry's reluctance to publish has made the question a difficult one to determine; but there is no doubt, on the evidence of his paper of 1832, that he obtained induced currents by means of magnets quite independently of Faraday, and may even have done so first. There is also no doubt of his claim to the honours for the discovery of self-induction, that is, the inductive effect of a current-carrying wire upon itself. The first mention of Henry's name in Faraday's Diary is in 1838; but that was after they had met, during Henry's visit to Britain in 1837. Afterwards there are a number of references, particularly to Henry's work on secondary and tertiary induction, which greatly interested Faraday.

If we leave the somewhat fruitless discussion of priorities, it is with the recognition that Faraday and Henry were the two great pioneers in the discovery of the induction of electric currents by means of magnets, a discovery which has been fraught with almost incalculable consequences to humanity. Thereafter, Faraday extended his researches to other branches of electricity; but Henry turned to another field when he accepted the invitation to become the first secretary of the Smithsonian Institution.

The motives of James Smithson, the illegitimate son of that Sir Hugh Smithson who married the Percy heiress and became the first Duke of Northumberland, in leaving his fortune to the United States of America, a country he had never visited, "to found at Washington an establishment for the increase and diffusion of knowledge among men", provide an interesting study We learn from this book what is of greater significance, namely, the extent to which Joseph Henry was personally responsible for preserving the Smithson fund intact and ensuring that it was devoted to its intended purpose—no mean feat in the America of his day Henry, by his selfless and inspired administration, not only created an institution but also established a great tradition of service to the best interests of his country

By his work for the Smithsonian, his service to the Light House Board, his share in the founding and activities of the National Academy of Sciences, and in many other ways, he became the acknowledged leader and organiser of American science He did not escape criticism and controversy In his earlier period he had invented the electromagnetic relay and set up the first telegraph line in his classroom at Albany, later he became involved, owing to the claims of Morse, in an acrimonious dispute regarding the invention of the telegraph Such incidents, however, served only to throw into relief the extent and importance of his scientific achievements His independence of mind and integrity of character were evident in his relations with President Lincoln and many other prominent Americans, with Wheatstone, Faraday and a host of scientific colleagues and friends, and in the recounting of these personal contacts, for example, that of Henry with the young Alexander Graham Bell, the character of a great man stands out from the pages before us

THOMAS MARTIN

# TEXT-BOOK OF MEDICAL PROTOZOOLOGY

Handbook of Medical Protozoology

For Medical Men, Parasitologists and Zoologists By Dr Cecil A Hoare Pp xv+334 (London Baillière, Tindall and Cox, 1949) 35s net

THE segregation of tropical medicine from general medical training is, as the author points out, purely artificial—particularly under modern conditions of rapid air-transport and closer association between the tropics and temperate climates Nevertheless, in British schools of medical training the study of the Protozoa and of the diseases caused by them is divorced from the general medical curriculum and assigned to the domain of tropical medicine, as a postgraduate study As a result, the medical student and the general practitioner in Great Britain have only a superficial acquaintance with the Protozoa parasitic in man, and have to turn to text-books to acquire at second hand the necessary information, and for lack of a suitable single text-book written in English and dealing only with medical protozoology, they have to acquire this information from text-books on tropical medicine, on parasitology, or on protozoology in general, such as that great classic which also emanated from the Wellcome Laboratories, "Wenyon's Protozoology"

The author tells us that he wrote this book in order to satisfy the demand for a short text-book devoted exclusively to medical protozoology and suitable for use not only by the general practitioner, but also by the more specialized clinical pathologist, parasitologist and laboratory worker Dr C A Hoare has admirably fulfilled his obligations, and, in addition, every teacher and research worker in tropical medicine will be grateful to him for having supplied them with an up-to-date, authoritative and concise work of reference

The subject-matter of Dr Hoare's book is divided into three parts, which deal with the Protozoa found in man from the general, the systematic and the diagnostic aspects, and in a work of such considerable importance it appears appropriate to consider these divisions separately Part 1, which represents about one-quarter of the book and which is divided into three chapters, gives a general account of the Protozoa The first chapter deals with their status, structure, reproduction and physiology, and it is pointed out that since the function of plants is perpetual synthesis, and that of animals is analysis, the spirochætes which synthesize their food supply fall into the former category and should be omitted from books on protozoology The second chapter describes the rules governing nomenclature and the principles used in classifying the Protozoa In this connexion it is of interest to note that *Dientamœba fragilis* is placed among the "flagellates of uncertain position", but owing to its amœboid phase, its morphology and life-cycle are considered along with the members of the Rhizopoda

The third chapter, which describes the ecology of the Protozoa, is one of the most interesting in the book, and the author's wide knowledge of the free-living, as well as of the parasitic Protozoa, has enabled him to write an illuminating and helpful account of the inter-relationship existing between man and this vast group of organisms When considering the definition of the term "host", the author refers to the lack of agreement concerning what constitutes the "intermediate host" and what the "final host", and, in order to avoid confusion, arbitrarily adopts the term "intermediate host" as being applicable only to the vector The problem of "host-restriction"—the author very rightly prefers this term to host-specificity—is dealt with in some detail, and the account shows clearly how with increasing knowledge most of the so-called "pathogenic protozoa of man" have been proved to parasitize also many non-human mammalian hosts There follows an interesting general account of the anatomical localization and of the tissue specificity of parasitic Protozoa, the description of the behaviour of individual species being considered later in the book The vexed question of biological races, a subject on which the author is a recognized authority, is briefly but adequately dealt with The succeeding nine pages are allotted to infection and resistance, and to the general aspects of protective vaccination In this connexion it is pointed out that protozoology lags behind bacteriology, and at the present time surprisingly little is known concerning how certain parasitic Protozoa produce their pathogenic effects, and that we are still very ignorant of the nature of the tolerance, resistance or immunity which in certain instances, is developed against their attacks.

The author refers, albeit very cautiously, to the possible production of toxins, but there seems little evidence of production of toxins by the malaria parasite or by the pathogenic trypanosomes, leishmaniasis and entamœbæ Under vaccination the author states (p 58) "The only protozoal disease in which vaccination is effective is cutaneous leish maniasis, whereas in other protozoal diseases all attempts at immunization have been unsuccessful" Presumably this statement refers to the practice adopted by the natives in the East of inoculating themselves with *Leishmania* on the arm or leg to prevent the possible acquirement of a disfiguring sore on the face , if so, such a practice can scarcely be considered as a method of preventive vaccination, since the course of the disease is not in any way modified, and it is only the site of the initial papule that is affected The treatment of the protozoal diseases is omitted, as being outside the scope of the work, but there is an excellent summary of the principles of chemotherapy as applied to the Protozoa, in which attention is directed to the importance of the development of drug-fastness especially in trypanosomiasis In a new edition (for it seems highly probable that this excellent work will demand a new edition), it would be worth while directing attention to the persistence of drug fastness through the insect vector, and to the important implications involved

The account of the ecology of the Protozoa concludes with a description of the geographical distribution of the diseases they produce For this purpose the author has brought together and summarized a mass of facts, previously widely distributed throughout the literature, concerning such important diseases as malaria, amœbiasis, trypanosomiasis and leishmaniasis, and he has shown how the establishment and spread of these diseases is influenced by such diverse factors as climate , the cultural level, habits, nutritional requirements and movements of the human population , the presence, density and habits of the insect vector , the presence, nature and abundance of animal reservoirs of the disease , and, finally, the effects of the introduction of new strains, a factor which has become increasingly important under modern conditions of widespread and rapid air-transport

Part 2, which contains some two hundred pages and which is the longest of the three parts, is devoted to a systematic account, not only of the pathogenic Protozoa parasitizing man, but also of the more common commensal Protozoa occurring in the gut and of certain coprozoic Protozoa, the appearance of which in the fæces may mislead the novice In addition, certain important species of trypanosomes common in animals, although not normally occurring in man, are described In each case the account given of a particular species includes relevant information under such headings as synonyms, relation to disease, geographical distribution, morphology and life history (including nutrition), reproduction, races, atypical forms, cultivation, host–parasite relationship, pathogenesis, immunity, incidence, infection in lower animals, transmission, viability and diagnosis These headings are taken from the account of *E histolytica*, and naturally less important parasites are not so fully considered , but in every instance there is a clear and adequate account which in the majority of cases could only be duplicated by a prolonged search through literature These descriptions are not a mere compilation of facts, but are critical summaries of those views with which the author finds himself in agreement Such a method of treatment is—to quote the author—"frankly didactic and somewhat dogmatic, which is unavoidable if the student is not to be confused with conflictory data and conceptions which he is not in a position to verify himself" The author has selected his authoritative statements with care, and it is doubtful if teachers of medical protozoology will differ from him except on points of minor importance

Part 3 is an excellent account of the more important diagnostic methods which may be employed in the recognition of protozoal infections, in the making of permanent preparations and in the cultivation of the human entamœbæ and hæmoflagellates The book concludes with a description of how mosquitoes, sand flies, tsetse flies and reduviid bugs should be dissected and examined for the presence of parasites transmissible to man

A short bibliography and an adequate index—a very important feature in a work of this nature—are provided There is a laudable absence of printer's errors , I have noticed only one significant misprint, "½ in oil immersion" in error for "1/12 oil immersion" (p 273) The illustrations, many of which are from original drawings by the author, are excellent and there are three fine colour-plates executed by Mr B Jobling, whose work is known to all students of protozoology The price of modern text-books is high , but in view of the excellence of the subject-matter and the fine standard achieved by the publishers, the price of 35*s* is more than reasonable

R M GORDON

# NEW DEVELOPMENTS IN PIEZO-ELECTRIC CRYSTALS

## Piezoelectric Crystals and their Application to Ultrasonics

By Dr Warren P Mason (Bell Telephone Laboratories Series ) Pp xi+508 (New York · D Van Nostrand Co , Inc , London Macmillan and Co , Ltd , 1950 ) 56*s* net

DURING recent years the research on piezo-electric crystals has extended from quartz and Rochelle salt to cover many new water-soluble synthetic materials Dr W P Mason has contributed a large part to the new development and has compiled a lucidly written book based mainly on published and unpublished investigations of the Bell Telephone Laboratories. The emphasis in this book centres on the presentation of new results rather than on known subjects, but for completeness the properties and applications of quartz and Rochelle salt are included

The first chapters are written in the form of a general introduction to piezo-electricity and contain —besides a survey of crystal systems, classes and symmetries—the elastic, piezo-electric and dielectric relations in crystals, given in tensor notation. The extent of the search for new materials can be seen from the chapter entitled "Properties of Crystals Determinable from Small Sizes", which contains a list of nearly two hundred crystals classified into four groups according to their coupling-strength The thorough investigation culminated in the discovery of ethylene diamine tartrate and the useful properties of dipotassium tartrate, which are replacing quartz crystals in electrical filters These materials have been treated in a separate chapter The properties of ammonium dihydrogen phosphate and potassium dihydrogen phosphate, a new ferro-electric type of crystal, are also discussed in detail

A chapter is devoted to information based on new measurements on a number of piezo-electric crystals belonging to different symmetry classes The considerable theoretical progress made in the past few years in analysing the properties of ferro-electric types of crystals and in locating the causes of the ferro-electric anomalies in Rochelle salt, potassium dihydrogen phosphate and barium titanate is clearly presented Dr Mason also discusses the electrostrictive effect in Rochelle salt and barium titanate, and presents data on the behaviour of these new ceramics as electro-acoustic transducer elements Applications of ultrasonics for the measurements of the physical properties of gases, liquids and solids are given in the remaining part of the book, which contains much new information The application of tensor calculus to the equations of liquids, gases and solids is included in an appendix

This book is not written as a text-book but as a report of the comprehensive work carried out in the Bell Telephone Laboratories during the past few years It should appeal not only to the crystal technologist and physicist but also to the crystallographer and chemist Dr Mason states that "the book can be regarded as an introduction to the study of piezo-electricity" , he is a very modest man

R BECHMANN

# FRACTIONAL DISTILLATION IN THE LABORATORY

Laboratory Fractional Distillation

By Thomas P Carney Pp ix+259 (New York The Macmillan Company , London Macmillan and Co , Ltd , 1949 ) 42*s* net

MANY organic chemists having no great background of physicochemical knowledge, and little facility in even elementary mathematics, have during the past ten years become aware that the technique of fractional distillation, perhaps the most ancient art of the organic laboratory, is in process of a rapid improvement that cannot be ignored Nevertheless, to do no more than pick from the mass of published papers the few worthy of closer study has not seemed easy

The declared purpose of the author of this book is to bring to the research worker and to the student an up-to-date and practical knowledge of the art of fractional distillation It may be agreed that this purpose is in large measure fulfilled for those readers in the United States for whom the book was written in the first instance British readers will find that this book has a number of shortcomings

The twenty-two chapters deal with most of the aspects of the subject which one would expect to find treated Space has been found for a good deal of matter which is not now of great practical importance, and there are many figures of obsolete equipment that could well be dispensed with The author's reluctance to use more than the irreducible minimum of mathematical development in his treatment of column operation, while understandable, does lead to difficulties of exposition It is a pity that space could not be found for adequate deductions of the Rayleigh equation and the Fenske equation, from first principles

There are occasional obscurities of language, for example, on p 18, and some statements which are quite misleading, as on pp 28 and 105 The British reader will be surprised to find no mention of the Dixon packing, which is certainly one of the most effective and is in wide use A rather odd feature of the bibliographical apparatus is that reference is not made to a number of standard text- and hand-books which give ampler treatment to many rather important distillation topics that Carney treats cavalierly or not at all , while, on the other hand, a large proportion of papers cited in the general bibliography in no way supplement textual material

There is much in this work that could be read with profit by any chemist who feels deficient in knowledge of the possibilities and limitations of fractional distillation. Some readers will think it could have been a shorter, better and cheaper book

E A COULSON

# THE SUGARS

Structural Carbohydrate Chemistry

By Dr E G V Percival Pp viii+246 (London Frederick Muller, Ltd , 1950 ) 25*s* net

THIS volume contains a readable account of modern views on carbohydrate chemistry and is well illustrated Within recent years considerable advances in technique and in the interpretation of the structure and reactions of mono- and polysaccharides have been made , the more important of these advances are described in this book The subject has been developed in a logical manner , the first chapter deals with the general properties and configurations of the monosaccharides For the student to possess a satisfactory knowledge of carbohydrate chemistry it is essential that he should be familiar with the configuration of the different sugars and with the changes which occur when pyranose and furanose rings are formed The first two chapters deal with these problems in an exceptionally lucid manner The next two chapters describe the characteristic reaction of the sugars The important reaction leading to the formation of sugar anhydrides is described in some detail, together with their conversion into amino sugars of known constitution Then follow chapters on the structure of oligosaccharides and polysaccharides

Since Dr E G V Percival, a pupil of the late Sir Norman Haworth, was among the first to determine the structure of a polysaccharide by the classical methylation procedure, it is no surprise to find that his experience has been embodied in these chapters, and that he has given an excellent account of the problems involved Chapter 8 describes the preparation, reactions and occurrence of the uronic acids This chapter contains a very useful account of the chromatographic separation of sugars and their derivatives by adsorption and partition procedures This is the first time a detailed account of this technique has appeared in a text-book of carbohydrate chemistry

The last three chapters deal with the chemistry of the glycosides and of other important sugar derivatives, and with the chemistry of some of the rarer polysaccharides In particular, a very useful account of inositol and its derivatives is included The reviewer considers that a little more emphasis might have been placed on the use of atomic models, especially in connexion with the reading of the first two chapters

This book should be in the hands of all honours students and on every library shelf The large number of references it contains makes it invaluable

# DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

## REPORT FOR 1948-49

THE annual report of the Department of Scientific and Industrial Research for the year 1948–49* includes the report of the Committee of the Privy Council, over the signature of the Lord President of the Council, that of the Advisory Council, over the signature of Sir Ian Heilbron, and the summary of work If anything, the one hundred and fifty or so pages of the report occupied by this summary, ninety-five of which are concerned with the work of the research associations, give an even more impressive picture of the contribution which science is making to the national welfare in every department of life, social as well as industrial, than was given by the pre-war reports The accounts of work are naturally less detailed than those given in the reports from the individual boards or institutions published separately, but the composite picture makes the report a reference book the value of which is enhanced by the details of the assessors and members of research boards and committees, the lists of establishments and research associations and of publications issued during the year which are included among the appendixes

Of the net expenditure of £3,273,109, annual grants to research associations amounting to £959,625 represent the largest single item, besides which special grants amounted to £59,317 Expenditure on the National Physical Laboratory was £689,528, against which £253,311 was received for work done for various boards and committees Net expenditure on building research was £233,179, on road research £214,676, on fuel research £147,405, on food investigation £141,135, on forest products research £84,710, on radio research £51,798, on water pollution £39,773, on pest infestation £33,571 and on mechanical engineering £17,972 Of the gross expenditure of £101,260 on the Chemical Research Laboratory, £39,584 was covered by receipts , receipts amounting to £18,308 covered more than half the gross expenditure of £36,002 on fire research projects Net expenditure on hydraulics was £8,501 and on the Geological Survey and Museum £142,728 (gross expenditure on the latter, £167,687) Net expenditure on headquarters administration was £79,237, on headquarters intelligence £32,109, and on headquarters overseas liaison £31,483 Research contracts accounted for £45,450 and grants for special researches for £268,379

Grants to students, etc , amounted to £160,598, and in a further appendix details are given of these grants in comparison with previous years Of the 736 grants to students-in-training, compared with 498 in 1947–48, 270 were in chemistry, 283 in physics, 61 in biology, 43 in engineering, 40 in metallurgy, 20 in geology and mineralogy, and 19 in mathematics and astronomy Of the twenty-three senior research awards (compared with twenty-five in 1947–48), twelve were in chemistry, six in physics, two in mathematics and astronomy and one each in biology, metallurgy and engineering Grants for special investigations numbered 99 as against 83 in 1947–48 and were distributed as follows 48 in physics, 21 in chemistry, 11 in engineering, 10 in biology, 7 in mathematics and astronomy, and 2 in geology and mineralogy

From the summary of work it is possible to do no more than select examples to illustrate the manifold ways in which the work of the Department contributes both to national welfare and industrial efficiency In the clay areas of the south of England widespread damage to dwelling-houses has been caused by seasonal movements accompanying the drying shrinkage of the clay beneath the foundations Detailed study of this problem by the Building Research Station has pointed to the need for placing foundations on shrinkable clays at a depth of at least three feet below ground-level and the importance of not planting fast-growing trees near the houses The Building Research Station has also studied the parallel problem of damage to industrial structures such as brick kilns, boilers, etc , caused by the drying shrinkage of clay due to penetration of the heat used in the industrial process A new kiln built to a design incorporating a series of transverse parallel arches in the foundation has given a small rise in temperature of the foundation soil after a year of service, indicating that the system is satisfactory Considerable attention has also been given to floor surfacing materials, while a systematic large-scale study of the properties of bricks from the many sources in Great Britain has been completed for the National Brick Advisory Council Besides work on the structures and strength of materials and on the efficiency of buildings, a branch laboratory of the Station has been opened at Thorntonhall, near Glasgow, to provide, besides information services and facilities for investigation, an exposure site for duplicating tests on building materials under different weather conditions

Of the work of the Chemical Research Laboratory, that which aims at the husbanding of material resources, particularly key materials, such as metals, and the work on metallic corrosion deserve mention here, as well as that on the utilization of indigenous raw materials, such as the extraction of gallium from flue dust and the separation and utilization of tar constituents, and the investigation of potentially interesting new processes and materials, like high polymers and plastics Of high industrial importance also are the researches leading to fundamental reference data, or which develop new methods and techniques Among the results obtained, the field of fire research may be mentioned , work here has included studies of fires in inflammable liquids, the development of a smaller apparatus for determining the 'figure of merit' for foam compounds, the development of an improved helmet for firemen and investigation of the fire risks of the gravity warm-air system in modern buildings, and of the behaviour of water-spray extinction systems

Food research has included the improvement of the quality of frozen meat imported from the southern hemisphere, the collection of whale meat for human consumption and fundamental research into the behaviour and properties of whale meat The poor condition in which most of the 'white' fish catch is at present landed is under investigation at the Torry Research Station, Aberdeen, where a fresh assessment of the possibilities of freezing at sea is under way Special attention has been given to the preservation of eggs by oiling, while work at the Ditton Laboratory, near Maidstone, has demonstrated that there are a number of English varieties of dessert apples, besides Cox's Orange Pippins, which might be grown commercially on a large scale in Britain and have the requisite storage properties to enable the home market to be supplied with dessert apples for a much longer period than at present. The feasibility of storing potatoes in warehouses, instead of in clamps, has been demonstrated, and methods for improving the quality of broccoli reaching the consumer have been indicated Fundamental work at the Low Temperature Research Station, Cambridge, has established a striking correlation between the ascorbic acid concentration and the concentration of sucrose in potato tubers, while ascorbic acid has also been shown to vary in cress seedlings with the nature of the medium in which the seedlings are grown

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* Department of Scientific and Industrial Research Report for the Year 1948–49 (Cmd 8045 ) Pp 260 (London H M Stationery Office, 1950 ) 5s 6d net

The chief large-scale project in the Forest Products Research Laboratory is the continuing series of tests upon Colonial timbers, particularly upon those of West Africa and British Guiana, aimed at finding means of replacing timbers traditionally obtained from 'hard currency' areas and finding substitutes for specialized timbers now scarce The Physics Section has studied further the fundamental constants of timber and its constituents, and reports have been issued on the natural durability of timber and the preservation of mine timbers At the Fuel Research Station research work on domestic heating has been advanced as rapidly as staff and equipment permitted, and a calorimeter building has been constructed containing four 'cabinets', about the size of ordinary living-rooms, in which various types of domestic heating appliances can be examined Other work has been concerned with the complete gasification of low-grade fuel, underground gasification of coal, smoke elimination and increasing the availability of water-tube boilers for continuous steaming The Geological Survey and Museum has touched on such important matters as water supplies and the exploration of radioactive mineral deposits Although the Hydraulics Research Station has still to be set up, under the Hydraulics Research Board major studies with the aid of scale models have been made of the River Forth, Rosyth Dockyard, and of the training works required to keep the deep-water channel in the Wyre estuary alongside the proposed wharf at Burn Naze and to maintain a navigable channel between Burn Naze and the sea

When the Mechanical Engineering Research Organization is fully developed at East Kilbride, the laboratories will have a staff of six hundred, including a hundred scientific officers organized in seven research divisions, covering the properties and strength of materials, mechanics of solids, stress analysis and vibration, mechanics of fluids, including hydraulic machinery, lubrication, wear and corrosion, mechanisms and engineering metrology, mechanics of formation and machine shaping of materials, heat transfer and applied thermodynamics Research on size effect in fatigue, complex stresses at high temperatures and the strength of screw threads is already being carried out for the Board at the National Physical Laboratory, and the Board has also given encouragement and financial support to a number of new researches at universities Among other work at the National Physical Laboratory may be mentioned the investigations on the aerodynamic properties of suspension bridges, with particular reference to the proposed bridge over the River Severn, on the provision of a radio service of standard frequency transmissions, on quantitative criteria of the definition of optical instruments, on the development of methods for producing test objects of accurately specified contrasts with the view of meeting the needs of photographic lens manufacturers for resolution tests at low contrast, on the metallurgical problems associated with the production of useful power from atomic energy, on engineering standards, on ship design and on a new design of ion source for the mass spectrometer

Outstanding features of the work of the Pest Infestation Laboratory during the year were the large-scale experiments with methyl bromide, which have indicated that completely effective fumigation of silo bins full of grain can be obtained by circulating the fumigant through the grain by means of suitable equipment Measurements of the toxicity to insects of DDT smokes and of the films of DDT formed by deposition of the smoke on building surfaces showed that deposits on the floor were twenty times as heavy as on the walls and ceiling, and contained about 66 per cent by weight of DDT against 12 per cent A patent has been taken out for a type of packing which has so far shown itself to be proof against insect penetration, while good progress has been made in dealing with the problem of blowflies in slaughter-houses

A major part of the programme of the Radio Research Board is concerned with the study in all its aspects of the propagation of electromagnetic waves under the conditions met with in practice and over the entire radio-frequency spectrum now available The study of the characteristics of the ionosphere at high frequencies has continued, as well as of the propagation of very short radio waves through the lower atmosphere and the problem of atmospheric noise arising from thunderstorms or other disturbed meteorological conditions The post-war work of the Road Research Laboratory on road materials and methods of road construction shows clear trends to an increasing study of road-making plant and machinery of all kinds, this includes a more intense study of road maintenance problems, chiefly in the direction of increasing the life of sprayed surface dressings and their bituminous carpet coats, and the development, by full-scale experiments, of the most economical form of surfacing for the prevailing traffic and soil conditions in any locality, and the best use of locally available materials A special joint committee has been formed with the Ministry of Supply to study soil problems, notably those concerned with the negotiation of bad ground by military vehicles, the provision of emergency airfields in forward areas and the construction of military roads by soil stabilization Road safety investigations have dealt with the problem of dazzle, the testing of brakes and pedestrian crossings Water pollution research has related to the treatment of sewage, the control of filter-flies and the repeated use of sea-water for cleansing shell-fish, as well as the treatment of industrial waste-waters

Space does not permit citing further examples of the interests of the Department, from the work of the forty research associations, some of which are making their own independent contributions in fields from which illustrations have already been given In the field of food research, for example, the British Baking Industries, the British Flour-Millers and the British Food Manufacturing Industries Research Associations are carrying out highly important work Some of the research associations are now operating on a considerable scale, the British Iron and Steel Research Association last year had an income of £368,189, while the British Coal Utilization Research Association, the British Cotton Industry Research Association, the British Electrical and Allied Industries Research Association and the British Shipbuilding Research Association all had incomes exceeding £200,000 Besides these, however, only the British Rayon Research Association (£187,501), the Wool Industries Research Association (£121,907), the Motor Industry Research Association (£108,720), the British Ceramic Research Association (£114,530), and the Parsons and Marine Engineering Turbine Research and Development Association (£104,058) had incomes of more than £100,000 Beyond this no more can be said than that the accounts of the work of the research associations are admirably written, and present a most convincing picture of the value of their contribution to industrial efficiency and national welfare.

The Department is to be congratulated on a report which fully maintains, if indeed it does not surpass, the standard of the pre-war reports, and it is welcome news that the Advisory Council has made arrangements that will enable future reports to be presented within a few weeks of the end of the year to which they relate

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# ELECTRON MICROSCOPE OBSERVATIONS ON THE SPERMATOZOID OF *FUCUS*

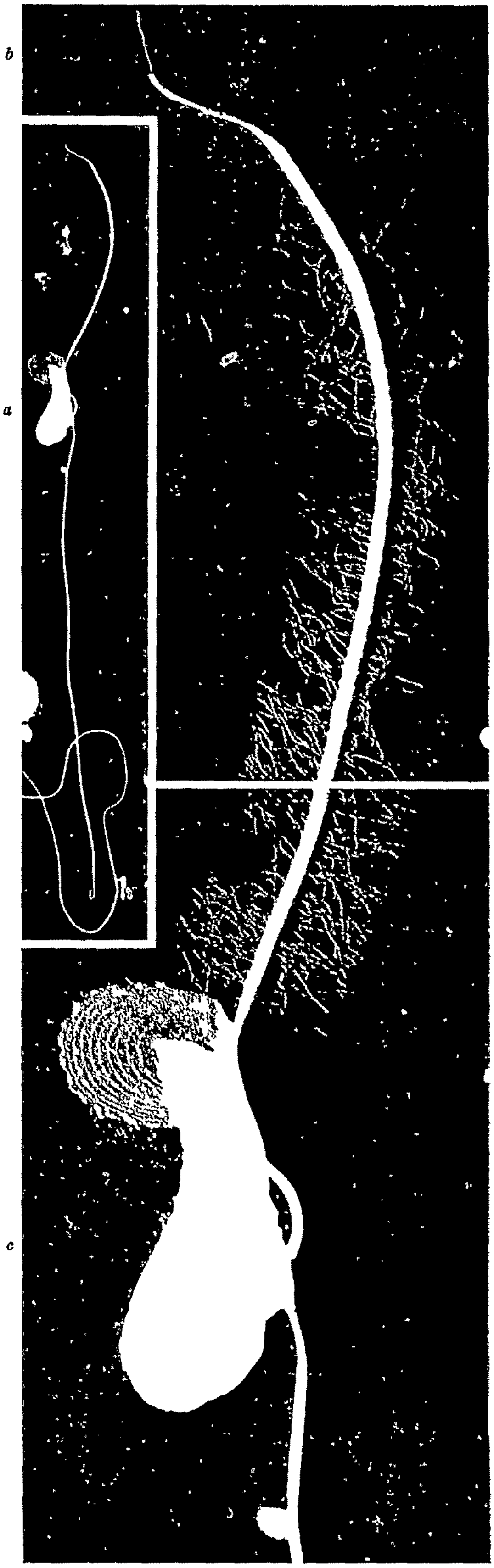
By Prof IRENE MANTON and B. CLARKE
University of Leeds

THE brown seaweed, *Fucus serratus*, is such a familiar object both on the shore and in class rooms that a preliminary note on the structure of its spermatozoid as revealed by the electron microscope may not be out of place

The accompanying micrographs have been taken with the new Philips's electron microscope, recently installed in the Botany Department of the University of Leeds with the aid of a grant from the Department of Scientific and Industrial Research The material had been killed with osmic vapour when swimming very vigorously and was preserved in formalin diluted with sea water Before mounting it was washed in distilled water, then dried on a 'Formvar' film and shadowed with uranium A single complete spermatozoid is shown in Fig *a*, with enlarged detail of the body and front end in Figs *b* and *c*

As regards the body (*a* and *c*), this is shrunken and somewhat distorted by the drying Its internal structure cannot be investigated in this particular specimen, though most of the gross features of its general shape are significant

The membranous appendage with the 'thumbmark' pattern (*c*) is one of the most interesting of these features Its presence, though not the details of its shape and markings, can be readily demonstrated with the light microscope if fresh spermatozoids are killed with osmic vapour and examined at once. It can then be seen as a transparent beak-like organ curving away from the base of the flagellum at the front end of the body This attitude is, how-



Electron micrographs (at 80 kV) of a spermatozoid of *Fucus serratus*, shadow-cast with uranium *a*, a complete cell (× 3,200), *b* and *c*, consecutive portions of the front end of the same specimen (× 16,000) ever the effect of chemical killing In life when the cell is swimming freely the front end has the shape of a very elongated, tapering and mobile snout, suggesting that the membrane is perhaps wrapped round the base of the flagellum and moving in unison with it If, however, the front flagellum becomes entangled with an obstacle so that forward movement is checked and the alignment of parts disturbed, the membrane can be seen as a separate organ as in *a*, even in the living cell The functional significance of the organ is at present unknown

The two flagella, seen complete in *a*, can also be seen with the light microscope if their motion is slowed down or if the cells are killed The hairy appendages on the front flagellum are, however, completely invisible except with the electron microscope, and they appear to constitute a definite morphological feature by which, in this species, the front flagellum differs from the hinder one These hairs can be demonstrated in fresh material killed with osmic vapour directly on the 'Formvar' carrier and dried down at once Under this treatment they are, however, very liable to fragment or fall off, and some hours hardening in formalin between the killing of the cells and mounting them for observation is undoubtedly conducive to better pictures The functional significance of the hairs is unknown, though it is not difficult to obtain indications, by watching the live spermatozoids, that the motions of the front and hind flagella are not the same The very long hind flagellum in our experience is always smooth, but much further work will be required before the mode of action of either is understood

It is premature to discuss these observations in detail or to attempt to enumerate all the other new facts which have already been obtained from this material It is, however, perhaps desirable to point out that hairy flagella have been described before in other organisms, though mostly on evidence which has been open to doubt[8] The first description of a "Flimmergeissel", as opposed to the smooth or "Peitschgeissel", appears to have been that of Fischer[1] in 1894, working with *Euglena* and *Monas* A 'Flimmergeissel" was, however, not only seen but also excellently photographed by Loeffler[2] in 1881, again in a flagellate of the *Monas* type, using his own recently invented method for staining bacterial cilia The hairs composing the "Flimmer" are, indeed, of the same order of size as bacterial cilia and, like them, can only be made visible under the light microscope by methods which increase their width, for example, by the use of an apposition stain By similar means "Flimmer" has since been described in other euglenoids[3], in some aquatic fungi[4], in certain brown flagellates (Chrysophyceæ)[5] and in the zoospores of some of the Heterokontæ among algæ[6] Two rather early sets of electron micrographs[7] are known to us, published in 1945 and 1947 respectively, in which "Flimmer" of the Euglenoid and *Monas* types can just be seen On the other hand, papers claiming that "Flimmer" is an artefact are very numerous and are still appearing[8] the latest known to us is dated 1949, but in view of the new observation on *Fucus* this last contention may perhaps now be finally allayed

We are not aware of any previous demonstration of "Flimmer" in the brown algæ as such, but our experience already suggests to us that this character may be found to have considerable phyletic as well as functional interest now that the details of it can be adequately seen

This work is being continued and will be published in greater detail elsewhere

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[4] Couch *Amer J Bot*, **28**, 704 (1941)

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# HEAT FLOW IN THE EARTH

At a meeting of the British Association, Section A (Mathematics and Physics), on September 4, 1950, at Birmingham, problems concerning the heat flow in the earth were discussed The Astronomer Royal was in the chair

Prof H Jeffreys spoke on "Potassium and the Earth's Thermal State" He said that though the heat output of the radioactive decay of the rare isotope of potassium ($K^{40}$) in the earth's crust is now smaller than that of the uranium and thorium series, it had been recognized that it might have been much greater in the earth's early history There are two decay schemes of potassium-40 with different decay constants $\lambda_\beta$ and $\lambda_e$

$$(1)\ K^{40} \rightarrow Ca^{40} + \beta\,,\ \text{decay constant} = \lambda_\beta$$
$$(2)\ K^{40} + \beta \rightarrow A^{40}\,,\ \text{decay constant} = \lambda_e$$

The determination of $\lambda_e$ (Ahrens and Evans[1]) was accomplished by the measurement of the amounts of potassium and calcium in specimens of lepidolite of known ages ($t$), which will enable $\lambda_e$ and $\lambda_\beta$ to be calculated from the following equations

$$Ca^{40} = 0\ 000109\,\frac{\lambda_\beta}{\lambda}(\exp \lambda t - 1)\,K + a, \text{ where } \lambda = \lambda_e + \lambda_\beta,$$

$$\text{and } A^{40} = 0\ 000109\,\frac{\lambda_e}{\lambda}\,(\exp \lambda t - 1)\,K$$

Using $\lambda_\beta = (0\ 51 \pm 0\ 04)/10^9$ years, which is known to be reliable, $\lambda_e = (1\ 91 \pm 0\ 16)/10^9$ years.

This seems likely to be an over-estimate, because of the initial calcium-40, for Prof A O Nier (private communication) has calculated from the relative abundance ratios of calcium-40 and -44 the radiogenic fraction of calcium-40 in the oldest lepidolites This works out to be only 0 2 parts in 10,000, whereas for $\lambda = 1\ 91/10^9$ years this ratio would be 0 8 parts in 10,000

On the other hand, $\lambda$ must be greater than $0\ 87/10^9$ years, for $\lambda_e$, as determined from the argon, some of which may have escaped, in potassium chloride of age $3 \times 10^8$ years is $0\ 36/10^9$ years

Suess and Poole[2] have calculated the argon generated by the disintegration of potassium in the granitic layer With $\lambda = 1\ 91/10^9$ years, this would work out at 214 gm /cm $^2$ in $2\ 1 \times 10^9$ years (the minimum age of the crust) and 2,200 gm /cm $^2$ in $3\ 3 \times 10^9$ years (Holmes's estimate). The actual argon in the atmosphere per unit area of the earth's surface is 13 gm /cm $^2$, and as one-tenth of the granitic layer has been denuded this value of $\lambda$ could be reconciled only with the minimum age of the crust

Later experimenters[4] find that the $\beta$-rays have a continuous distribution of energy with a mean of $(0\ 5 \pm 0\ 1)$ MeV, giving a heat generation of

(13.4 ± 2.9) MeV/sec/gm potassium or (1.60 ± 0.35) × $10^{-5}$ cal/gm potassium per year. Ahrens and Evans[1] and Graf and Gleditsch[3] give the γ-ray energy as (1.5 ± 0.5) MeV, so that the total heat output is (2.26 ± 0.36) $10^{-5}$ cal/gm potassium per year (cf. Bullard's value[5]), which is much less than the output by uranium and thorium.

In the theory of the earth's thermal state it is necessary to compute the limiting temperature $S_0$ at the base of the radioactive layer after a long time, changes of radioactivity being ignored. The contribution of potassium to $S_0$ (revising Bullard's work[5]) is 120°, and its contribution will change with time as $\exp \lambda T$. As $S_0$ on these data works out as 880°, the temperature of the interior would be above the melting point $T_m$ when $\exp \lambda T_m$ is 7, that is, at times less than Holmes's estimate of the age of the crust (see table).

| $\lambda$ | $T_m$ |
|---|---|
| 1.9/$10^9$ years | 1 × $10^9$ years |
| (1.43 ± 0.26)/$10^9$ years | 1.4 ± 0.3 × $10^9$ years |

However, if an initial fluid state is supposed, solidification in the mantle would begin from the bottom upwards, and when complete, fractional crystallization would take place. As is indicated by the observed separation of materials at the surface, the residual liquid between the grains would be squeezed upwards, taking with it the radioactive constituents until their concentration at the surface allowed $S_0$ to drop and solidification occurred everywhere.

It appears, accordingly, that $S_0$ could not be above the melting point after a solid crust was formed, and that if a theory leads to the opposite result it must have assumed either too great an age or too great an average depth of the radioactive constituents (since $S_0$ contains this average depth as a factor).

Dr. S. K. Runcorn spoke on "The Geomagnetic Secular Change and Thermal Convection in the Earth's Core". He said that the discovery, by seismologists, that the earth's core, 3,500 km. in radius, is a liquid of viscosity less than $10^6$ poise, has proved to be the essential clue in the interpretation of the geomagnetic secular change. For it is only by postulating fluid motions in the core that the paradox between the rapid change in the geomagnetic field, in certain places reaching 50 per cent in a hundred years, and the time-scale of geological phenomena can be explained. In particular, the remarkable westerly drift of the points of maximum annual change (the isoporic foci), noticed in older data by Van Bemmelen[6] and Bauer[7] and rediscovered by Vestine[8] in his survey of the geomagnetic field between 1905 and 1945, cannot be explained except by fluid motions in the core, the magnitude of which are thus found to be 0.05–0.1 cm./sec. The absence of any north–south component of the velocity of the isoporic foci can be shown to be a direct consequence of the predominance, for motions of this magnitude, of the Coriolis term in the hydrodynamical equations of the core.

Bullard[9,10] and Elsasser[11] have discussed possible causes of the motions in the core and have come to the conclusion that astronomical causes are not sufficient and that thermal convection must be postulated.

Bullard supposes that a small concentration of radioactive material (about 5.5 times that found in iron meteorites) is present in the liquid core, generating a total of 5 × $10^{12}$ cal./sec. This he shows will maintain a temperature gradient equal to the adiabatic one (1.1° C./km.), despite the flow of heat through the surface of the core under this temperature gradient (3.4 × $10^{-6}$ cal./cm.² sec., as the thermal conductivity* is calculated to be 0.31 cal./cm. deg. C.). An amount of heat must be removed from the mantle equal to the amount generated if the adiabatic gradient is to be maintained. The temperature gradient in the mantle will be that given by the change of the melting point of the basic silicates with pressure, which equals 3° C./km. near the surface of the earth. The thermal conductivity of the basic silicates is about 5 × $10^{-3}$ cal./cm. sec. deg. C., so that the heat carried away through the mantle is 0.15 × $10^{-6}$ cal./cm.² sec. Though the constants on which these figures are calculated are not known with accuracy, it appears that unless slow convective motions are occurring in the mantle this convection model is untenable.

Elsasser suggests an alternative model in which he supposes that the core is effectively thermally insulated, but that certain of the heavy oxides of uranium and thorium found their way to the solid central body within the core, just as the concentration of the radioactive compounds in a thin shell of the mantle is presumably due to the fact that the halides of uranium and thorium are gaseous. He shows that, supposing the radioactive content of the central body per unit surface area is about five per cent of that of the crust, 1.1 × $10^{-6}$ cal./cm.² sec. will be generated, which exceeds the heat conducted away from the central body through the core under the adiabatic temperature gradient. Thus convection is maintained, the liquid core heating up through about 300° C. during the life-time of the earth.

Dr. P. L. Willmore pointed out that the latter view is not compatible with the generally accepted view of a cooling earth.

Dr. G. M. Lees said that before the impact of geophysical speculation on geological processes, geologists had attributed the zones of compression, which formed fold and thrust mountain ranges, to the effects of shrinkage of the earth's core, and a slow cooling had appeared to supply an adequate mechanism. The discovery of radioactivity, indicating the continuous development of new heat, upset this simple conception and released a tide of new ideas. Various forms of giant, deep-seated convection currents, continental drift, permanence of oceans, and isostasy, had been invoked in the search for an adequate mechanism to explain observed facts, but a satisfactory solution has eluded us so far. Recent speculations on the inner shells and core of the earth by Ramsey, based on Bridgman's high-pressure researches, show that there are many factors which had not been appreciated earlier, and Dr. Lees asked whether the review of all aspects of the outward flow of earth heat would allow geologists to revert to their original conception of a shrinking earth.

Prof. Jeffreys, in reply, said that the thermal contraction of the earth gave an answer of the right order of magnitude to the problem of the cause of mountain building. If the problem of a uniformly cooling body is solved for the case of radial symmetry, it is found that the frequency of mountain building should not decrease with time, which agrees with the evidence but is not the conclusion of the earlier calculations, which attempted to discuss the problem as a unidimensional one

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* In this calculation the electrical conductivity of the core is taken as 5,000 ohm$^{-1}$ cm.$^{-1}$

Dr D R Inglis directed attention to Prof Urey's view that the lighter constituents of the earth might have condensed first Thus heavier materials trapped in the outer parts of the earth might drop down through the core from time to time This might provide an explanation of the variations of the length of the day and would also provide an alternative explanation of the cause of core motions

S K RUNCORN

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## OBITUARIES

### Prof R J D Graham

PROF ROBERT JAMES DOUGLAS GRAHAM died at his home in St Andrews on September 3 He was born at Perth on July 20, 1884, the son of Dr John Thomas Graham, medical officer for Perthshire After an early education at Perth Academy, Graham entered the University of St Andrews in 1901 Somewhat uncertain as to the course of study to pursue, he began with an M A degree in 1904 At first he was inclined to follow a career in the Church, but he made early and stimulating contacts with Prof Patrick Geddes, with Sir D'Arcy Thompson, and later with that very enthusiastic teacher, Prof R A Robertson, the first holder of the chair of botany at St Andrews The influence of these men swayed Graham entirely to the side of science, and it was Robertson who made him a botanist By 1906 he had completed with distinction his science degree in botany, zoology and geology Thereafter he continued for a brief period as a Carnegie Scholar at St Andrews and spent some months in Germany familiarizing himself with the language

Early in 1907 Graham was appointed an economic botanist in the Indian Agricultural Service After a short stay at Pusa, where for a time he deputized for the Imperial Economic Botanist, he was directed to the more permanent post of economic botanist to the Government of the Central Provinces He was the first to occupy this post, which he held from 1908 until 1917 Graham thus had a wide field in which to operate, including the establishment of college curricula and the organization of a considerable amount of research work on the applied aspects of his subject To that end he was enabled to visit many agricultural institutions throughout India and to equip the Central Provinces with a very adequate scheme of development He was much interested in the improvement by selection and hybridization of wheat, rice, millet, linseed, potatoes, oranges, etc A decided measure of success attended this work, particularly in the production of rust-resisting wheats and improved strains of rice and millet, so much so that for some years after he had left the Provinces it could be said that many thousands of acres were sown annually with strains of cereals evolved by him One of the many results of his work was the composition of a thesis—"The Economic and Systematic Botany of the Central Provinces of India"—which was accepted by his old University as qualifying him for the degree of D Sc in 1917

It was evident from the first that Graham possessed a flair for administration, and this was fully exemplified in the years to come In the First World War he immediately volunteered for active service, but it was not until November 1917 that permission was granted Then he joined the Indian Army Reserve of Officers as a second lieutenant and forthwith was directed to Mesopotamia In view of his previous experience in the science and practice of agriculture, he was within a few months appointed assistant director of agriculture with the rank of lieutenant-colonel In this capacity he continued until March 1919, when his qualities induced the authorities to appoint him director of agriculture and also director of military farms He occupied this responsible position until he was released from military service in 1920 His department was regarded officially as one of the most efficient and popular in Mesopotamia, and he was duly mentioned in dispatches

Upon his retiring from service in the East in 1921, he was invited by Sir Isaac Bayley Balfour to join the University of Edinburgh as a senior lecturer in botany For nearly thirteen years he took a full share in the teaching of large classes, particularly in courses of plant physiology, plant breeding and genetics

In 1934 he was appointed to succeed his old teacher, Prof Robertson, in the chair of botany at St Andrews, where his ability for administration again received early recognition Year after year he was re-elected dean of the Faculty of Science, and for six years was chosen by the Senatus as an assessor to the University Court In these fields he was a conspicuous success—without detriment to the work of his chair In addition to his own Department he had the general supervision of the Department of Botany at Dundee His influence was well seen in the completion of the botanical laboratories, in the development of a very fine University Botanic Garden with an extension by the Firth of Tay devoted to the cultivation of sea-shore plants, and in the re-establishment of the Gatty Marine Laboratory His own studies, as well as his attraction to plant physiology and applied botany, led him to devote much of his attention to vegetative propagation In this he had the close co-operation of the late Mr L B Stewart, and from this association there resulted numerous publications

Graham was elected a fellow of the Royal Society of Edinburgh in 1924, he was a member of Council during 1938–39, and a vice-president for the period 1944–47 For some years he was honorary secretary of the Botanical Society of Edinburgh and president in 1942–43 Almost yearly expeditions into the hills gave him a very complete acquaintance with the Scottish alpine flora On these excursions he was in his element, for he was as vigorous in body as in mind At St Andrews he took a great interest in all the social and athletic activities of the student body As he had joined the University Rugby Club in 1901 and was captain in 1906, he could enter into the direction of sports with zest, and until a few years ago could take a share in the field of play

Only recently did his stalwart frame show any indication that all was not well, and he was warned that he must exercise great care. But he continued to work until the day before his death, and then passed away very peacefully in his sleep. His many friends abroad and at home share in the deep loss sustained by St. Andrews—a loss to which expression has been given from many quarters. He is survived by his wife, one son and three daughters.

W. Wright Smith

## Prof. R. Goldschmidt

The death occurred on October 30 of Prof. Rudolf Goldschmidt, a pioneer of electrical engineering, at the age of seventy-four.

Goldschmidt was born in Mecklenburg on March 19, 1876. Although the first years of his life were spent in modest surroundings, and his parents had intended him for a merchant career, his scientific talents and independence of mind soon asserted themselves. He studied engineering at the technical colleges at Berlin and Darmstadt, where he became lecturer at the age of twenty-one. In 1900 he entered industry, and came to England in 1902, joining Messrs. Crompton-Parkinson, Ltd., Chelmsford; later he went to the Metropolitan-Vickers Electrical Co., Ltd. (then the Westinghouse Co.), in Manchester.

By this time his original technical thinking and inventive genius were already recognized in wider circles, and he had a number of books, papers and patents to his credit, chiefly concerned with alternating current machinery. In 1905 he received an award from the Institution of Electrical Engineers.

Goldschmidt returned to Darmstadt in 1907 as reader, later professor of electrical engineering. He occupied this chair, however, for a few years only, as his most important invention now preoccupied him. This was the high-frequency alternator, a machine which at the time revolutionized wireless telegraphy and entered text-books as the Goldschmidt alternator. It permitted, for the first time, telegraphing without cable from Germany to the United States. He built the large wireless station at Eilvese, near Hanover, and a similar American one at Tuckerton, being director of the former and of the 'Homag' (High Frequency Company) throughout the First World War. A historical exchange of greeting telegrams between President Wilson and the Kaiser (who ceremonially opened his station a fortnight before the War) is still among his souvenirs. This and later work brought him some of the highest public honours in Germany.

After the War many other inventions occupied his mind, in particular an electric hammer which is widely used to-day, the British development being the 'Kango' hammer. His versatility enabled him to contribute to the most diverse scientific fields, the patents ranging from internal combustion engines to telephones and a pulse-recording machine. Among his friends he counted Prof. A. Einstein, with whom he co-operated on one invention.

He lived in Berlin during 1911–34, when he emigrated to England with his family as a refugee from the Nazis, being of Jewish faith. He became a naturalized British subject in 1939. In Britain his inventive activity continued. Among other things he developed a new type of deaf-aid, and in order to test this, he subjected himself to six operations, the last one impairing his hearing.

During the Second World War he pursued, with the support of the Air Ministry, some inventions of special character, putting all his energy into the war effort in his own manner. He lived in London, but in 1940 joined his son in Sheffield. Here he became consultant, later member of the staff, of the B.S.A. Group Research Centre, working chiefly for the B.S.A. Co., Ltd., Birmingham, on several projects, and moved to Birmingham in 1949. During these last years, though more than seventy years of age, he still devoted his whole life to his work with youthful energy, to the admiration of his colleagues and many friends, until his fatal illness in August last.

Dr. Goldschmidt married in 1905. His wife died in 1933; he leaves one daughter and three sons. Despite his technical preoccupation, he was a man of outstanding charm and personality. His sense of humour, generosity and kindliness, his love of Nature and of children were his chief qualities. He was a patient teacher who loved nothing better than to pass on his deep knowledge to his students and associates.

## Prof. S. J. Truscott

There is not a mining field throughout the world where the death on September 26 of Samuel John Truscott will not have been noted with sorrow. By personal contact at the Royal School of Mines, at meetings of the Institution of Mining and Metallurgy and by visits overseas, he was known personally to many, and those who did not have the pleasure of meeting him have derived great benefit from his writings. He was a great teacher, a strict adherent to what is best in his profession and a prolific and stimulating writer.

He was born in 1870, received his scientific training at the Royal School of Mines, and then obtained a wide professional experience over twenty-seven years in overseas mining fields, particularly in the East Indies and in South Africa. He was of Cornish descent and had all the traditional Cornish love of adventure. As a young man he gloried in the life of the mining fields, such as Malaya, 1889–92, and the Witwatersrand, 1894–97.

In 1913 Truscott returned to the Royal School of Mines and in 1919 was elected to the chair of mining, which he held until 1935. His lectures were remarkable for their clarity, illustrated by an astonishing knowledge of modern developments derived from his personal experiences and close study of the technical journals in the English, French and German languages.

Truscott was president of the Institution of Mining and Metallurgy (1920–21), was awarded its Gold Medal in 1937 and made an honorary member in 1948. The University of the Witwatersrand conferred on him an honorary doctorate in the Faculty of Engineering in 1930 and he was elected an honorary fellow of the Imperial College in 1945.

He published a number of treatises on mining subjects, two of which, namely, "Ore Dressing" and "Mining Economics", are the standard works in their respective subjects in the English language.

In manner he appeared to be somewhat austere; but there was an imp of mischief which peeped out unexpectedly to the complete astonishment of his students and his younger friends. His older friends knew him as a generous warm-hearted friend who was always ready to put his great knowledge at their disposal.

J. A. S. Ritson

# NEWS and VIEWS

## Prof E D Adrian, O.M., F.R.S. President of the Royal Society

The election of Prof E D Adrian to the presidency of the Royal Society will bring great pleasure throughout the world of science, both in this further homage to the distinction of his work and also in that the Royal Society will have those personal qualities which have made his recent ambassadorial work for Unesco and as Foreign Secretary to the Royal Society so conspicuously successful Prof Adrian's work has had a profound effect on the course of biological science in the last two decades His early training with Keith Lucas and in clinical neurology up to 1918 equipped him to make full use of the opportunities to re-investigate much of nervous function presented by the advent of the valve amplifier, which enables the messages passing in nerve trunks to be tapped and recorded with instruments rapid enough to follow them but too insensitive to be used without amplification In 1926 his discovery with Zotterman of the rhythmic discharge of impulses by a single sense organ in muscle was rapidly followed by many observations showing this to be a general principle of signalling used throughout the nervous system, in motor as well as sensory nerves With many pupils and collaborators in the following years, many of the outstanding uncertainties of sensory function were made plain He then turned his attention to the electrical changes of the brain and, following Berger's early work on these, laid the foundation of electro-encephalography, which has since become an important new branch of neurology In recent years his work has been on olfaction and has given us objective facts on which further understanding of this most baffling of the sense organs can be built

Prof Adrian's work has been characterized by simplicity in conception, going straight to the fundamental point where the new techniques could supply the missing links in the older knowledge This has led him far afield in comparative neurology, from the optic ganglion of the water beetle to the auditory nerve of the alligator the cortex of the pony, ape, or himself have all provided material for his experiments His work has mapped out many new fields of experiment which have become active fields of research all over the world In spite of the extreme difficulty of many of the techniques he has used, his experiments are all done by his own hands, which have a skill in operation that is deceptive in the speed with which a preparation is made His work, presented either in papers or lectures, has a clarity and simplicity that reveal a mind under the sternest logical discipline and with complete freedom from obliquity in thought, and whether he speaks to a learned society or to a class of medical students, his audience are made to understand matters they thought too difficult for them

## Electrical Engineering at University College, London: Prof. F Brailsford

Dr. F. Brailsford has been appointed as from January 1, 1951, to the second chair of electrical engineering, tenable at University College, London, with special responsibility for heavy-current work He has a very wide experience in industrial research, having been a member of the staff of the Research Department, Metropolitan-Vickers, Ltd , Manchester, since 1929 In recent years he has given close attention to magnetic materials, and he is particularly well known both in Great Britain and in the United States for his important contributions in that field of study Dr Brailsford's little book on "Magnetic Materials", published in 1948 as one of "Methuen's Monographs", is an authoritative work In the academic sphere Dr Brailsford has had experience as a part-time teacher both at the University of Manchester and at the Manchester College of Technology He took a London B Sc (Eng ) external degree with first-class honours in 1927 and Ph D (Eng ) in 1939 As a full member of the Institution of Electrical Engineers, he has been awarded the Kelvin Premium and the Mather Premium of that Institution for scientific papers presented to it

## British Railways Research Organization

The Railway Executive has decided to integrate the research facilities of the different regions of British Railways into a single Research Department This is in accordance with the recommendation of a committee set up by the British Transport Commission under the chairmanship of Sir William Stanier The Department will be under the control of a Director of Research responsible directly to Sir Eustace Missenden, chairman of the Railway Executive It will have seven divisions, each under the immediate control of a superintendent The divisions will be (1) Chemistry, embracing existing laboratories in each region , these laboratories will continue to be concerned with work arising in the regions, but major researches of a chemical nature will be allocated to whichever laboratory is most suitable (laboratories are situated at Ashford, Crewe, Darlington, Derby, Doncaster, Glasgow, Horwich, Stonebridge Park, Stratford, Swindon and Wimbledon , headquarters in London) , (2) Engineering , (3) Metallurgy , (4) Protective Coatings , (5) Physics , (6) Textiles , (7) Operational Research (headquarters in London) Divisions 2–6 will be at Derby, where the necessary laboratory facilities and staff already exist , there will also be a subsidiary engineering laboratory at Ashford The Research Department will establish a central library and information centre

The appointments have already been announced of Mr T M Herbert, formerly research manager, L M S , to be director of research, and of Mr E Morgan to be assistant director The following appointments as superintendents of the various divisions of the new Department have been made Mr T Baldwin (senior assistant (engineering), Scientific Research Department, Derby), Engineering Division (Derby) , Mr T H Turner (chief chemist and metallurgist, Mechanical and Electrical Engineering Department, Doncaster), Metallurgy Division (Derby) , Mr T A Eames (senior physicist, Scientific Research Department, Derby), Physics Division (Derby) , Mr F Fancutt (paint technologist, Scientific Research Department, Derby), Chemistry Division (Euston) , Mr C G Winson (textile technologist, Scientific Research Department, Derby), Textile Division (Derby) , Mr M G Bennett (manager, General Research Department, Euston), Operational Research Division (Euston)

## International Film Coupon Scheme

A scheme has been organized by the United Nations Educational, Scientific and Cultural Organization which will enable soft currency countries to purchase educational, scientific and cultural films from hard-currency areas, and will facilitate purchase and sales between one soft-currency country and another. So far, twenty-four countries have joined in the project. Coupons will be marketed in Great Britain by the British Film Institute, 164 Shaftesbury Avenue, London, W.C.2, which will also be the central body dealing with imports and exports under the scheme. Intending purchasers must satisfy themselves that the particular film they want is educational, scientific or cultural, and also make sure of the availability and price of the film. The British Film Institute will provide the necessary import form and in due course obtain the film, clear it through Customs and hand it over to the purchaser. Where the Institute receives a request from abroad, supported by the appropriate coupons, for the purchase of British films, it will get into contact with the owner and make arrangements for shipment; payment for films purchased in this way will be made by the Institute. No orders for non-British films will be accepted from a foreign purchaser, and films must be supplied to foreign purchasers by outright sale without any contingent payments.

### British Jute Trade Research Association: Annual Meeting

At the annual general meeting of the British Jute Trade Research Association, held on November 14 in the offices of the Association, Kinnoull Road, Kingsway West, Dundee, the chairman of the Council, Mr. George E. Scott, in moving the adoption of the accounts and annual report for the year ending June 30, said that a considerable expansion in staff and plant has taken place during the past year. Commenting on the great increase in basic knowledge relative to jute, Mr. Scott said that all sections of the industry are utilizing the facilities made available by the technical inquiry service of the Association, particularly with regard to day-to-day problems; the steady increase in the number of such inquiries illustrates the reliance on the work of the Association. Mr. Scott also referred to the publicity value of the research station to the industry, impressing as it did upon users of jute goods the desire of the industry to do all within its power in the provision of quality products and materials for special purposes. The director of research, Mr. H. Corteen, reviewed the different ways in which the Research Association can be of assistance to its members. In order to hasten the practical application of the results of research conducted in the Association's laboratories and workshops, a series of training schemes are being set up, whereby personnel of member firms can be trained in particular aspects of work. During the day of the meeting, approximately 170 of the supervisory personnel of member firms visited the Association's premises and were shown the various research investigations being carried on, this being the first 'open day' organized by the Association for that purpose.

### X Disease of the Peach

A virus attacking peach and chokecherry (*Prunus virginiana*), and rather appropriately known as X disease, is now of considerable importance in the north-eastern United States. Ernest M. Stoddard (Conn. Agric. Exp. Sta. Bull. 506; pp. 19. New Haven, U.S.A., May 1947) has investigated methods of spread and possible control of the trouble. The virus is transmitted by budding or grafting, but not by mechanical means; it can spread on chokecherries and from them to peach, but not from peach to peach and, in all probability, not from peach to chokecherry. An obvious method of control is to eliminate chokecherries from the neighbourhood of peach orchards. It is, however, claimed that the virus is inactivated in diseased living peach buds by soaking such buds in aqueous solutions of chemicals which include various sulphonamides, quinolines, and even calcium chloride. Living peach trees can also be immunized against artificial inoculations of X disease by watering the soil with various aqueous solutions. Heat treatment of peach buds is also claimed to lower the infectiveness of the virus. It would appear that important issues are raised by this work—so important that, without any disrespect to the author, they merit independent confirmation.

### *Ceylon Coconut Quarterly*

The coconut industry is a major industry in Ceylon and almost entirely in the hands of the Ceylonese. Coconut products are the second best exchange earner for the island. In December 1928 an Ordinance to provide for the establishment of a Coconut Research Scheme became law, though its finances were always inadequate. The Ordinance required that the board of the Research Scheme should, by the provision of information, give practical assistance to persons engaged in the industry. Hitherto, it had only been possible to issue advisory leaflets at irregular intervals with an occasional article in the *Tropical Agriculturist*. But the absence of a regular journal was always felt as a serious omission. The *Ceylon Coconut Quarterly* has now come into being (1, No. 1, January–March 1950. Lunuwila: Coconut Research Scheme). Messages of welcome are published from the Prime Minister of Ceylon and the Ministers of Agriculture and Lands, the Food and Co-operative Undertakings, and Commerce and Trade. As the Prime Minister points out, neglect in the plantations existed before the Second World War, and during the War cultivation, manuring and replanting were not done. The establishment of nurseries and the dissemination of young seedling plants by the Research Centre has done much to improve crops. It is said that the yields from crops grown from the specially selected nuts and seedlings may yield 5,000 nuts per acre, instead of the average 1,800 from more or less uncultivated plantations. The aim of the *Quarterly* is to provide information of all kinds on the subject of the industry and to make the information available not only to the larger growers, but also to the smallholders, who form the majority of the coconut producers.

### Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: W. T. Dalgarno (senior agricultural officer, Nigeria), principal farm industries officer, Department of Commerce and Industries, Nigeria; M. W. Gibbon (senior agricultural officer, Nigeria), principal agricultural officer, Nigeria; A. E. Moss (senior agricultural officer, Gold Coast), assistant director of agriculture (cocoa industry), Gold Coast; R. J. M. Swynnerton (senior agricultural officer, Tanganyika), assistant director of agriculture (field services), Kenya; D. A. Russell (principal, Government Technical School, Takoradi, Gold Coast), chief inspector of education (technical), Nigeria; J. F. Bates, entomologist, British Guiana; F. A. Carver, agricultural officer, Fiji; C. R. Dickson, agricultural officer, Gold Coast; L. Johnson, economic botanist, Trinidad; A. S. MacDonald, agricultural officer, Sierra Leone, J R Milburn, agricultural officer, Federation of Malaya, R E Rowe and A I Taylor, agricultural officers, Nigeria, E N G Cooling, conservator of forests, Northern Rhodesia, K M. Lamb, assistant conservator of forests, Nigeria, R M Lawton, assistant conservator of forests, Gold Coast, D S. Lowson, R H M. Nisbet and J D Whitaker, assistant conservators of forests, Federation of Malaya, P Hardwick and F Whyte, geologists, British Guiana, L Piper, geologist, Nigeria, W N Woodhead, geologist, Sierra Leone, S J Curry, scientific officer (entomologist), Anti-Locust Research, Cyprus, Dr M. T Gillies, medical research officer, grade 3 (medical entomologist), East Africa Malaria Unit, East Africa High Commission, J F Griffiths, scientific officer (micro-climatologist), Desert Locust Survey, T M Docker, veterinary officer, Tanganyika, R C Armstrong, sociological research officer, Nigeria, W P Bewy, livestock officer, Veterinary Department, Tanganyika, H S Gair, geologist, Northern Rhodesia, D L Jennings, research officer (genetics), East African Agriculture and Forestry Research Organization, E H O Martin, fisheries officer, Tanganyika, C W Montgomery, soil survey officer, Gold Coast, Miss J E Mulholland, statistician, Medical and Survey Department, East Africa High Commission, H N Sanson, meteorologist, East Africa High Commission, J S Scott, fisheries officer, Fisheries Department, Federation of Malaya, A M S Smith, assistant conservator of forests, Uganda, J J Soulsby, fisheries officer, Northern Rhodesia, C G. N Warren, agricultural survey officer, Gold Coast

## Crosby Hall Scientific Exhibition

UNDER the auspices of the Crosby Hall Endowment Fund, a Scientific Exhibition will be held at the Imperial College of Science and Technology during December 26–30 Together with practical scientific demonstrations, films will be shown and a series of lectures will be given Among those who will be lecturing are Dr G. M Bennett, Miss Enid Blyton, Mr L J F Brimble, Prof Winifred Cullis, Miss Mary Field, Sir Alexander Fleming, Prof H Hartridge, Dr H S Holden, Dr A Hunter, Prof R P Linstead, Mr. Robert Silvey, Dr Keith Simpson, Dr Marie Stopes, Dr W E Swinton, Dr Mary Waller, Sir Robert Watson-Watt and Dr W D Wright Further information can be obtained from Miss R Part, Crosby Hall Endowment Fund, Crosby Hall, Cheyne Walk, London, S W 3

## University of London Appointments

IT is announced from the University of London that Dr C H Dowker has been appointed to the University readership in mathematics tenable at Birkbeck College The title of reader in the University has been conferred on the following in respect of the subjects mentioned Mr D N de Garis Allen (applied mathematics, Imperial College of Science and Technology), Dr R J Harrison (anatomy, Charing Cross Hospital Medical School), Mr E J Pryor (mineral dressing, Imperial College of Science and Technology)

## Announcements

MR T A BRINKLY, an experimental officer at the Atomic Energy Research Establishment, Harwell, has been appointed research assistant to Prof E W. Titterton, of the Australian National University, Canberra

Dr E M Crowther and Mr F C Bawden have been appointed deputy directors responsible for the Soil Division and Plant Pathology Division respectively of Rothamsted Experimental Station.

DR A R LEE has been appointed a deputy director at the Road Research Laboratory, Department of Scientific and Industrial Research His duties will concern research on materials and methods of construction of roads He will have the rank of a deputy chief scientific officer By this appointment the two sides of the work at the Road Research Laboratory will each have a deputy director responsible to the director of road research (Dr W H Glanville), Dr. R J Smeed, the other deputy director, is concerned with the work of the Safety and Traffic Division Dr Lee will be best known to road engineers for his work on bituminous road materials and surfacings

MR GEORGE L V HOOTON has been appointed a lecturer on the staff of the Department of Education of the International Wool Secretariat Mr Hooton, who is a graduate of the University of Leeds, and comes of a Yorkshire sheep-farming family, will lecture on all aspects of wool, both in the schools and in the field of further education, in the West Riding of Yorkshire and in the north of England generally.

THE fourth Louis Bleriot Lecture of the Royal Aeronautical Society will be given in London on February 23, 1951, by M Maurice Roy, who will speak on "Power Versus Weight in Aviation". The thirty-ninth Wilbur Wright Memorial Lecture of the Society will be given in September 1951 by Mr A E Raymond, vice-president (engineering) of the Douglas Aircraft Co, Inc, of California, the exact date and title of the Lecture will be announced later Further details may be obtained from J Laurence Pritchard, secretary of the Royal Aeronautical Society, 4 Hamilton Place, London, W 1

THE British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund, is offering, for award in June 1951, up to three prizes of maximum value £150 for papers on chemistry, physics, engineering or chemical engineering, having a bearing on plastics or polymers, read during September 1950–June 1951 before the Plastics Institute or its branches, or the Plastics and Polymer Group of the Society of Chemical Industry, including the symposium or the convention held in connexion with the British Plastics Exhibition in June 1951, alternatively a paper may be submitted direct Contributions must reach the general manager of the British Plastics Federation, 47–48 Piccadilly, London, W 1, not later than June 29, 1951

UNDER the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and Colonies to go to the United States for academic or educational purposes, provided that they have the financial support in dollars for the visit and are affiliated to an American institution of higher learning The Fulbright grants cover the cost of travel from the candidate's home to America and return, and are available during June 1, 1951–May 31, 1952 Further details can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W 1, applications must be submitted by March 31 (those travelling between June 1 and July 31) or July 1 (those travelling after August 1)

# RADIOCHEMICAL EQUILIBRIA IN IRRADIATED WATER

By Dr. P. BONET-MAURY and M. LEFORT
Laboratoire Curie, Institut de Radium, Paris

THE formation of hydrogen peroxide in water to which sulphuric acid and titanium sulphate have previously been added, by exposure to X- and alpha-radiation, has already been studied[1]. The hydrogen peroxide combines, as rapidly as it is produced, to form a stable coloured titanic complex. It would be expected that under these conditions subsequent radiodecomposition of hydrogen peroxide would be prevented, so that the whole of it produced by the various reactions which lead to its formation during irradiation may be measured by the photocolorimetric method already described[2].

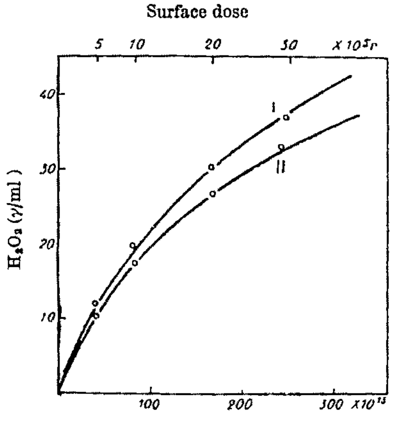
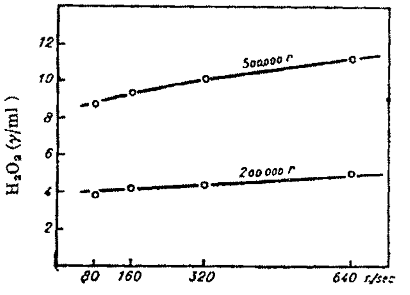


Fig. 1. I, Reagent before (intensity 650 r./sec.), II, reagent after (intensity 650 r./sec.)

If water, brought to the same $pH$ (1·2) by addition of sulphuric acid, is irradiated under the same conditions but in the absence of titanium sulphate, and the latter is added after the end of irradiation, then the measured production of hydrogen peroxide is not the total amount produced but an amount corresponding to equilibrium between the rate of formation and the rate of destruction characteristic of the particular radiation intensity used. (The intensity of the absorbed radiation is defined as that amount of energy transferred to unit volume of water in unit time; it may be expressed in ergs/ml./min., in eV./ml./min., or in ion pairs/ml./min.) If one compares the yield of hydrogen peroxide when the reagent is added before, with that when it is added after, the irradiation, one can evaluate the importance of the decomposition reactions. By varying the amount of sulphuric acid, the whole range of $pH$ from 1·2 to 7, corresponding to pure water, may be investigated; by substituting hydrochloric acid for sulphuric acid, we ensured that the effect observed depends upon the $pH$ and not upon the anion. The alkaline $pH$ range may also be investigated by the addition of suitable reagents.



Intensities (100 r./sec. = 8·4 × $10^{13}$ i.p./ml./sec.)

Fig. 2. Effect of intensity ($pH$ 1·2)

(a) $pH$ 1·2. At the maximum intensity feasible with our equipment (650 r./sec.), X-rays give hydrogen peroxide in amounts smaller than those obtained when the reagent is added before the irradiation (Fig. 1). For a given dose the relation of formation of hydrogen peroxide to intensity is shown in Fig. 2. Increasing the duration of exposure was without effect in our previous studies[1]. In the case of alpha-radiation, neither the time at which the reagent is added nor the duration of exposure has any effect on the yield of hydrogen peroxide so long as the initial intensity is higher than 0·5 mC./ml. or 0·8 × $10^{13}$ ion pairs/ml./sec. (table, p. 982). At lower intensities, a slightly smaller yield is recorded, which may reasonably be ascribed to the fact that the duration of exposure was much greater (48 hr.), so that the variation in the radiation intensity due to decay of the radon was no longer negligible.

(b) *Variable* $pH$. In the case of X-radiation, the amount of hydrogen peroxide produced depends on the $pH$ when irradiations are carried out at a constant dose and constant intensity (Fig. 3). At $pH$ 7, the concentration of hydrogen peroxide is about one-half that produced at $pH$ 1·2, whereas at $pH$ 12 it is only one-third that at $pH$ 1·2.

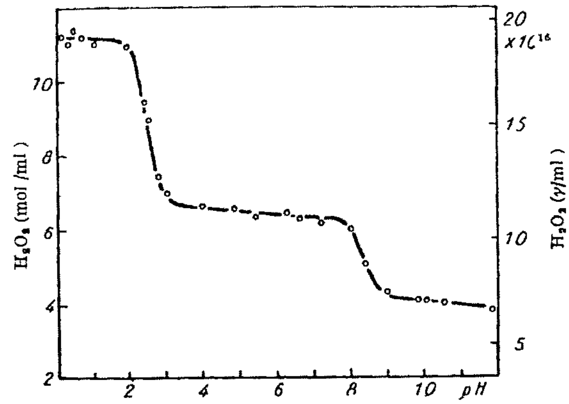


Fig. 3. Effect of $pH$ (intensity 640 r./sec.)

Changes in $pH$ do not alter the formation of hydrogen peroxide by alpha-rays when the radon concentration is higher than 0·5 mC./ml., but an appreciable diminution is observed with lower concentrations.

(c) $pH$ 7. *Pure water saturated with oxygen.* Hydrogen peroxide formation by X-rays depends on the intensity at which the dose is delivered, and the relation of the final concentration observed to this intensity is shown in Fig. 4. It is remarkable that the hydrogen peroxide production by alpha-rays is independent of the radiation intensity when the initial radon concentration is higher than 1 mC./ml. The smaller yield of hydrogen peroxide observed at lower concentrations seems to be due to secondary decom-

RADIOCHEMICAL YIELD ($t = 18°$)

| | | | With titanic reagent | With sulphuric acid | Pure non-degassed | | Pure oxygen-freed |
|---|---|---|---|---|---|---|---|
| | *p*H | | 1 2 | 1 2 | 7 0 | | 7 0 |
| X-rays | Intensity | r /sec | 640 | 640 | 640 | 160 | 640 |
| | | i p /ml /sec | $5\ 4 \times 10^{14}$ | $5\ 4 \times 10^{14}$ | $5\ 4 \times 10^{14}$ | $1\ 34 \times 10^{14}$ | $5\ 4 \times 10^{14}$ |
| | Initial yield | $G_i$ | 2 7 | 1 95 | 1 05 | 0 60 | 0 |
| | | $M/N$ | 0 9 | 0 65 | 0 35 | 0 20 | 0 |
| | Yield for $10^{18}$ i p /ml | $G_{10^{18}}$ | 1 25 | 1 0 | 0 63 | 0 27 | 0 |
| | | $M/N$ | 0 42 | 0 35 | 0 21 | 0 09 | 0 |
| α-rays | Intensity (i p /ml /sec ) | | $8 \times 10^{12}$ | $8 \times 10^{12}$ | $8 \times 10^{12}$ | | $8 \times 10^{12}$ |
| | $G$ | | 0 9 | 0 86 | 0 86 | | 0 86 |
| | $M/N$ | | 0 28 | 0 275 | 0 275 | | 0 275 |

position reactions occurring during the long duration experiments

*Radiochemical yield* The radiochemical yield, $G$, is practically constant for alpha-rays (initial intensity higher than $8 \times 10^{12}$ i p /ml /sec ) · $G = 0\ 9$, that is, 0 29 mol of hydrogen peroxide per alpha ion-pair. It is assumed that the average energy expended in producing an ion-pair by alpha-radiation is 35 eV

For X-rays, on the contrary, this yield largely depends on the experimental conditions It increases with temperature, intensity and concentration of dissolved oxygen, but decreases with dose and *p*H In the accompanying table both the initial yield (dose ~ 0) and the yield resulting from a given dose ($10^{18}$ i p /ml ) have been recorded The former is believed to correspond to the rate of production of hydrogen peroxide and to be unaffected by decomposition reactions, the latter represents the equilibrium between formation and decomposition under the conditions of the experiment These results demonstrate that the X-ray yield in pure *p*H 7 aerated water may sometimes be higher and sometimes lower than the alpha-ray yield, according to the intensity and the dose used in the irradiation Densely ionizing particles alone give a radiochemical yield higher than that of electrons in oxygen-free water, in which the yield is practically zero for electrons in this case

These experiments support the interpretation which we proposed for our previous results, according to which hydrogen peroxide formation by X- and alpha-rays is controlled by two separate mechanisms These mechanisms are conditioned by the geometrical distribution of the hydroxyl and hydrogen ion groups resulting from the ionization and excitation of the water molecules If it is assumed that in the case of alpha-rays only the hydroxyl groups play a part in the phenomenon, then the very high local concentration of these radicals along the track of the particle would account for the fact that the yield of hydrogen peroxide is practically independent of *p*H and also of intensity, despite the fact that the intensity determines the mean concentration of hydroxyl radicals throughout the bulk of the solution. In the case of X-rays, on the other hand, the hydroxyl and hydrogen ion local concentrations approximate closely to the mean concentration and may be influenced by intensity and *p*H variations

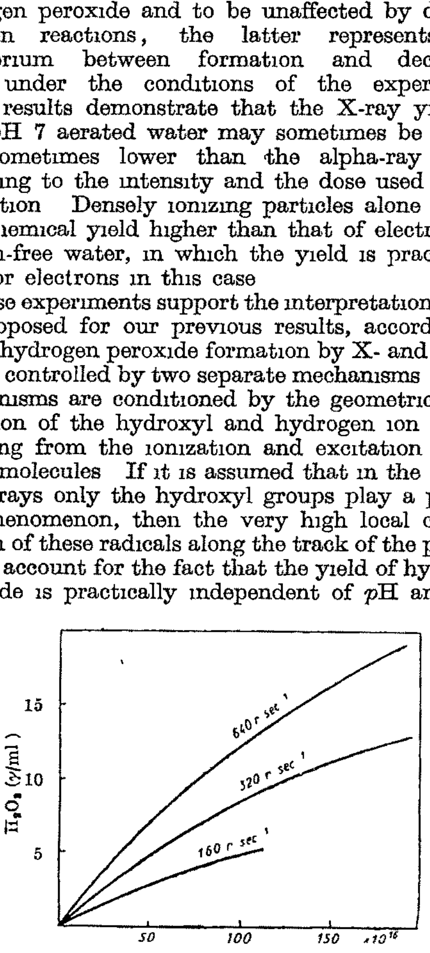


Fig 4 Effect of intensity (*p*H 7)

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[1] Bonet-Maury, P , and Lefort, M , *Nature*, **162**, 381 (1948)

[2] A recent review of this subject will be found in the reports of the symposium held in 1948 at the Notre-Dame University (Indiana U S A ), published in the *J Phys and Coll Chem* , 52 (1948)

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THERE is general agreement that during the oxidation of most intermediary metabolites (succinate appears to be exceptional), about three atoms of phosphorus may be esterified per atom of oxygen consumed[1-4]. Belitzer and Tsibakowa[5] and Ochoa[6] pointed out that a ratio greater than one implies that the phosphorylation reaction must occur at more than one point in the respiratory chain over which the hydrogen atoms of the substrate pass on their way to oxygen Later, Lehninger[2] was able to show that, with β-hydroxybutyrate as substrate, all the phosphorylation occurred between reduced cozymase and oxygen and none between substrate and cozymase With substrates such as pyruvate or α-ketoglutarate the primary dehydrogenation that is, that between substrate and the first acceptor might also contribute to phosphorylation[7]

The location of the phosphorylation has now been narrowed by experiments in which cytochrome *c* was used as the final acceptor of hydrogens from the substrate The reoxidation of cytochrome *c* was prevented, either by adding cyanide or by excluding oxygen α-Ketoglutarate has been used exclusively as substrate, but further experiments are planned with other substrates

Since the amount of hydrogen transfer was limited by the amount of cytochrome *c* used as hydrogen acceptor, it was necessary to employ a sensitive method of determining the phosphorylation By adding glucose and hexokinase, the inorganic phosphate which disappeared was finally obtained as glucose-6-phosphate This was measured on the

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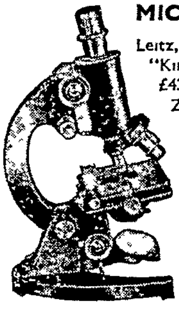

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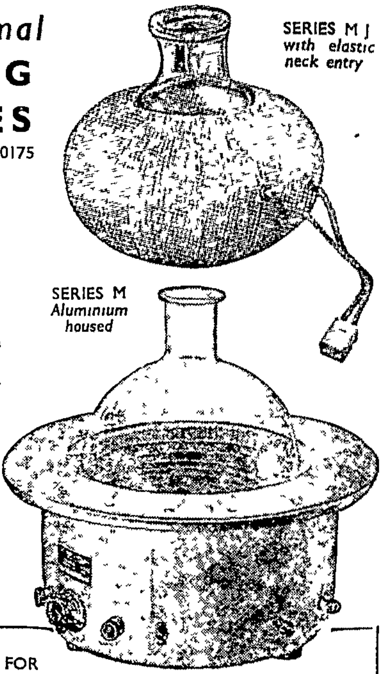

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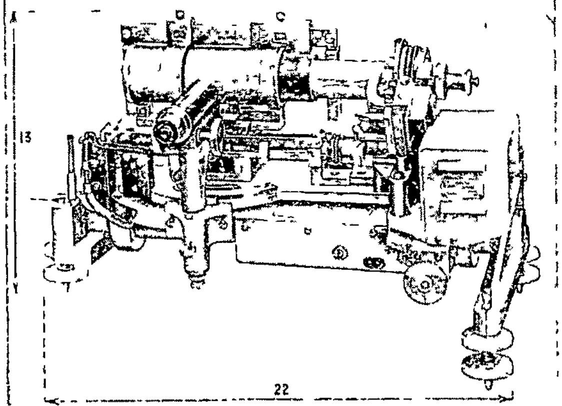

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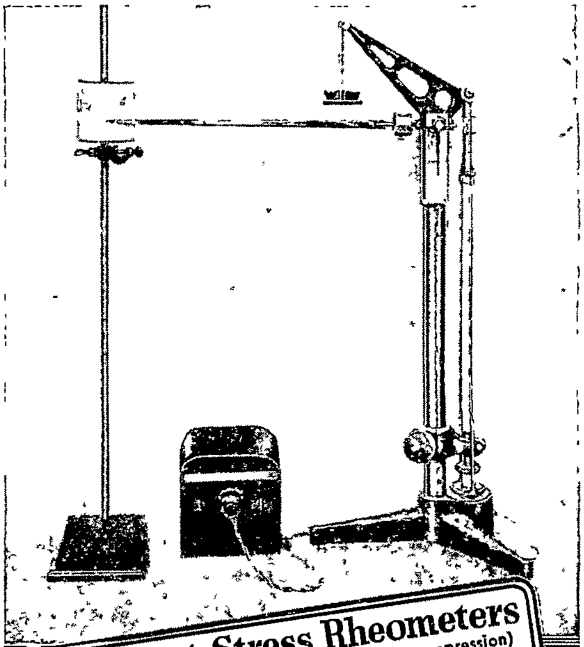

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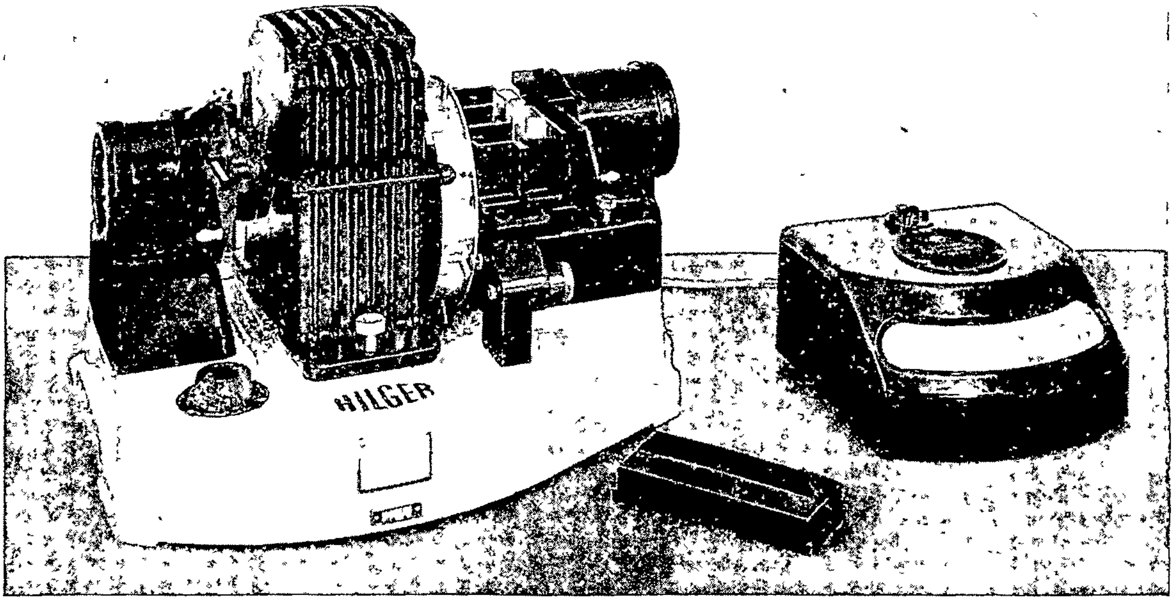

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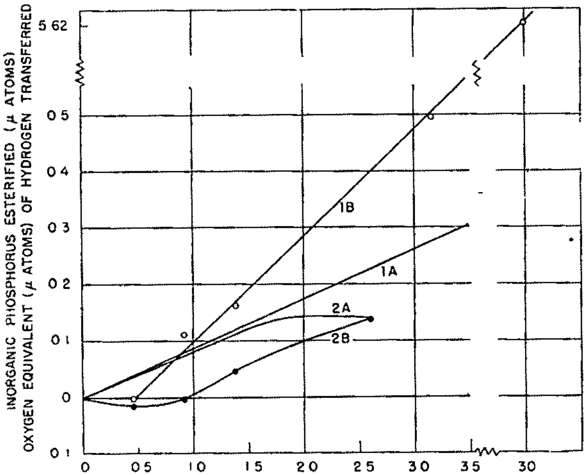

Esterification of inorganic phosphate during oxidation of α-ketoglutarate by oxygen (curves 1*A* and 1*B*) or cytochrome *c* (curves 2*A* and 2*B*) NaF, 0 04 *M*, phosphate buffer, *p*H 7 3, 0 0348 *M*, glucose, 0 0167 *M*, cytochrome *c*, $10^{-4}$ *M*, adenylic acid, 0 001 *M*, adenosinediphosphate, 0 001 *M*, α-ketoglutarate, 0 0067 *M*, hexokinase, Mg, 0 005 *M*, 0 1 ml heart muscle preparation (1 6 mgm fat-free dry weight) in all flasks Curves 2*A* and 2*B* contained, in addition, 0 01 *M* potassium cyanide Curves *A*, hydrogen transfer, Curves *B*, hexose phosphate formed Temperature 23 3–24 4° in different experiments, times adjusted to correspond to 24 4°, assuming $Q_{10} = 2$

supernatant from a trichloracetic acid precipitation by a sensitive enzymic method (based on Racker's[8] method of determining hexokinase activity)

Under the experimental conditions, adenosinediphosphate was much more efficient than adenylic acid as primary phosphate acceptor Adenylic acid was also added, however, in order to inhibit myokinase, which caused an appreciable transfer of the terminal phosphorus of adenosinediphosphate to glucose in the absence of any oxidation Fluoride (0 04 *M*) was added to inhibit adenosinetriphosphatase

The enzyme preparation used consisted of washed granules obtained by differential centrifugation of an extract prepared by grinding washed cat heart mince with sand and phosphate buffer, *p*H 7 3

The accompanying graph shows the results in which both oxygen and cytochrome *c* were used as the final hydrogen acceptor In the latter case, 0 01 *M* potassium cyanide was added to prevent the oxidation of reduced cytochrome *c* The rate of hydrogen transfer was followed manometrically in the first case and spectrophotometrically (increase of absorption at 520 mμ) in the second The values shown have been corrected for a zero time blank and for a very small esterification obtained in presence of cyanide, but in the absence of cytochrome *c* (due to slight myokinase activity)

It is apparent that whether oxygen or cytochrome *c* was the final hydrogen acceptor, there was an initial lag of phosphorylation behind hydrogen transfer. In fact, when cytochrome *c* acted as the acceptor, most of the glucose phosphate was formed after the cytochrome *c* was completely reduced This lag must be due to the accumulation, in the very early stages of the reaction, of an intermediate in the overall phosphorylation reaction The intermediate could be either adenosinetriphosphate or a compound formed prior to it, or both

When oxygen is the final hydrogen acceptor, the effect of the lag on the measured phosphorus–oxygen ratio can be made negligible by running the experiment for a sufficient period It is apparent from the value obtained at 30 min in the graph that the phosphorylation system is stable for at least this period under the conditions used The effect of the lag on the phosphorylation coupled with the reduction of cytochrome *c* can be minimized by allowing the reaction to proceed for some time after all the cytochrome *c* is reduced

The accompanying table summarizes an experiment in which the phosphorus–oxygen ratio obtained with cytochrome *c* is compared with that obtained with oxygen as final hydrogen acceptor The reoxidation of the cytochrome *c* was prevented in three ways (1) by using oxygen-free nitrogen as the gas phase, (2) with 0 001 *M* potassium cyanide, (3) with 0 01 *M* potassium cyanide

The cytochrome *c* was completely reduced in 5 6 min When 0 001 *M* potassium cyanide was

ESTERIFICATION OF INORGANIC PHOSPHATE DURING OXIDATION OF α-KETOGLUTARATE BY OXYGEN OR CYTOCHROME *c*

Volume, 3 1 ml Fluoride, 120 μ moles, phosphate buffer, *p*H 7 3, 109 μ atoms P, glucose, 50 μ moles, adenylic acid, 3 μ moles, adenosinediphosphate, 3 μ moles, Mg, 15 μ atoms, hexokinase, 0 2 ml heart muscle preparation (3 3 mgm. fat-free dry weight) in all flasks Other additions as shown

| No | α-Ketoglutarate (μ moles) | Cyt *c* (μ moles) | Conc of potassium cyanide (*M*) | gas phase | Time[1] (min) | Hydrogen acceptor | Oxygen equivalent of hydrogen transferred (μ atoms) | Glucose phosphate[2] found (μ moles) | Δ*P* (μ atoms)[3] | P O |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 0 | 0 | Air | 30 | Oxygen | 1 26[4] | 2 15 | 2 10 | 1 67 |
| 2 | 20 | 0 058 | 0 | Air | 30 | Oxygen | 2 20[4] | 6 13 | 6 08 | 2 79 |
| 3 | 20 | 0 464 | 0 | Air | 30 | Oxygen | 2 20[4] | 5 53 | 5 48 | 2 50 |
| 4 | 0 | 0 058 | 0 | Air | 30 | Oxygen | 0 | 0 05 | — | — |
| 5 | 20 | 0 464 | 0 | Air | 6 05 | Oxygen | 0 44[5] | 0 82 | 0 80 | 1 80 |
| 6 | 20 | 0 464 | 0 | Nitrogen | 8 5 | Cyt *c* | 0 23[6] | 0 51 | 0 49 | 2 16 |
| 7 | 20 | 0 | 0 | Nitrogen | 8 5 | None | 0 | 0 01 | — | — |
| 8 | 20 | 0 464 | 0 001 | Air | 5 59 | Cyt *c* | 0 23[6] | 0 36 | 0 30 | 1 29 |
| 9 | 20 | 0 464 | 0 001 | Air | 7 88 | Cyt *c* | 0 23[6] | 0 50 | 0 40 | 1 76 |
| 10 | 20 | 0 464 | 0 001 | Air | 10 25 | Cyt *c* | 0 23[6] | 0 63 | 0 50 | 2 20 |
| 11 | 20 | 0 | 0 001 | Air | 5 59 | None | 0 | 0 06 | — | — |
| 12 | 20 | 0 | 0 001 | Air | 10 25 | None | 0 | 0 13 | — | — |
| 13 | 20 | 0 464 | 0 01 | Air | 8 16 | Cyt *c* | 0 23[6] | 0 24 | 0 22 | 0 98 |

[1] Experiments carried out between 23 2° and 24 7° and times adjusted to correspond to 24 2°, assuming $Q_{10} = 2$

[2] Corrected for zero time control (0 162 μ moles)

[3] The following control values were used in calculating Δ*P*
Nos 1, 2, 3 value obtained in No 4, namely, 0 05 μ mole
Nos 5, 6, 13 ,, ,, ,, No 7, namely, 0 015 μ mole
No 8 ,, ,, ,, No 11, namely, 0 06 μ mole
No 10 ,, ,, ,, No 12, namely, 0 13 μ mole
No 9 interpolated figure from Nos 11 and 12, namely, 0 10 μ mole

[4] Measured manometrically

[5] Calculated from manometric measurement

[6] Total ferricytochrome *c* added Reduction was complete in 5 6 min

used, the phosphorus–oxygen ratio (2 molecules of cytochrome *c* taken as equal to 1 atom of oxygen) reached 2 20, 4 6 min after all the cytochrome *c* was reduced  The single value obtained under anaerobic conditions was 2 16, obtained 2 9 min after complete reduction  These values are minimal, since it is possible that higher ratios might have been obtained had the experiment been prolonged  These values may be compared with 1 80 for a short-time experiment and 2 50 in a long-time experiment, when oxygen was the final hydrogen acceptor  (The high concentration of cytochrome *c* used, $1\ 5 \times 10^{-4}$ *M*, inhibited the phosphorylation slightly, a ratio of 2 79 was obtained with $1\ 9 \times 10^{-5}$ *M* cytochrome *c* ) It is clear from the last line of the table that 0 01 *M* potassium cyanide inhibits phosphorylation considerably

These experiments suggest that all the phosphorylation which occurs when $\alpha$-ketoglutarate is oxidized by oxygen occurs in those steps of the hydrogen transfer reaction between substrate and cytochrome *c*

Full details will be published elsewhere

I wish to express my thanks to Prof S Ochoa for his advice and encouragement, and the Rockefeller Foundation for the opportunity to join Prof Ochoa's Laboratory

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# SUBJECTIVE JUDGMENTS

ON October 14, a meeting arranged as a private venture by a committee with Dr R G Hopkinson (Building Research Station, Department of Scientific and Industrial Research) as secretary, was held at University College, London, to discuss subjective judgments  The attendance was large, the discussions were extremely lively, the views put forward were varied enough to satisfy the most determined opponent of uniformity, and altogether it was apparent that the problems raised are now attracting widespread and active attention both from the point of view of fundamental research and from that of the most appropriate methodology to be used in the study of a great many practical problems concerning human health, efficiency and comfort

The morning discussion raised again the question of the measurability of sensation  After Sir Frederic Bartlett, who was in the chair, had opened the conference, Dr D B Fry, of the Phonetics Department, University College, London, said that what is called 'measurement' in the case of sensation is the correlation of some aspect of the magnitude of a stimulus with some dimension of magnitude in the sensation  This is empirically possible  The magnitude usually, but not necessarily, adopted in the case of the sensation is a minimum perceptible difference in some assigned dimension , but as a subject can also compare different values of the same dimension and determine that in one case he has a value or magnitude which is a certain fraction of another, or a certain 'number of times' greater than another, there is ground for believing that quantitative sensation scales are feasible  It is not to be supposed that the dimensions of the stimulus are themselves a measure of the sensation, or that the number of discriminable dimensions of the sensation are necessarily equal to the number of physically measured dimensions of the stimulus  All that is needed is a certain consistency in the assigned relations of measured stimulus differences and sensation dimension differences, and these relations have to be treated by statistical analysis  Whether this is 'measurement' can be disputed  That it is both possible and useful is certain

With Prof R C Oldfield, University of Reading, some of the results of the impact of modern general machine theory upon the interpretation of sensory evidence came into the picture  The attempt to set up psycho-physical scales is one depending upon the empirical determination of a function of a physical stimulus variable which is such that its values correspond with judgments made by a subject in accordance with a given character  The early dualism of stimulus-sensation has broken down completely, for we have always to take into account the characteristic structure and internal variable state of whatever response system or device is set at work in our experiments  In the case of psycho-physical judgments, there seem to be three characters of the internal responding device which are remarkably persistent, though whether they are always in operation and what particular mathematical formulation of relationship they demand are still matters for determination  The first is an element having two positions of equilibrium  This may mean—and in most cases of psycho-physical judgment it usually does mean—"a non-linear transformation of the external variable", for example, to a logarithmic form, and such transformation may involve temporal derivations of the external variable  The second is a shifting standard, structurally built into the response system, and together with the first character, leading to a discontinuous 'all-or-none' expression of continuous change in the external variable  The third is an 'indifference range', which means that there is no apparent change of output or interpretation within experimentally determined limits of 'stimulus' variation, but that outside such limits marked change may suddenly appear  Whether the functional relations of a physical stimulus variable with a sequence of step-judgments based upon sensorial likeness and difference could be in any sense regarded as a 'measure' of sensation, Prof Oldfield refused to say  But he did consider that their elucidation would show that the process of judging physical stimulus magnitudes could be regarded legitimately as fully amenable to quantitative treatment.

Dr W D Wright asserted categorically that sensation magnitudes cannot be measured, for there is no form of yardstick that can be laid alongside them  Discrimination data cannot be used, because the magnitude of a discrimination may be dependent upon any of a number of variables, both external and internal, and nobody can know which are operating  Contrast-qualities cannot be used because all the results of trial are equally consistent with a number of different assumptions and we have no crucial way of actually determining which is necessary Thus no formally expressed relationship between stimulus and sensation has any validity , but this does not prevent the commonly adopted logarithmic scales of intensity from having great practical value

This discussion was continued by Dr R W Pickford, Prof H Hartridge, Mr F H Brittain and Mr J M Waldram, of the Research Laboratories of the General Electric Co , Ltd , and Dr M H Pirenne

Dr Pickford was not much inclined to believe that sensations are, in any literal sense, measurable , but he gave illustrations to show that the commonly accepted correlations of stimulus and sensation variations are of operational value In a written communication Dr Pirenne expressed substantially the same view

Prof Hartridge showed that subjective observations carried out entirely independently by Granit and himself in the field of colour identification agreed remarkably closely, both in a qualitative sense and in regard to associated frequency values of the physical stimuli

Mr Brittain made an interesting suggestion of a physical model the operations of which might be regarded as strongly analogous to those of a human perceptual mechanism This reinforced the view that no measure of input, or stimulus, could be valid which failed to pay attention to the character of the transforming and conducting processes internal to the responding system

Mr Waldram described some original and important illustrations of the use of stimulus-sensation correlations of a quantitative order

Following this the discussion became general and open, and a large number of provocative and downright remarks were made It is perhaps fair to say that there was exceedingly little agreement on any fundamental question, but almost complete agreement that even if sensations cannot be measured, they must be, and that the attempts which have been made are of great practical service

In the afternoon meeting, the chair was taken by Dr F M Lea, director of the Building Research Station (Department of Scientific and Industrial Research) The topic assigned was "The Subject as an Assessor of Sensation" , but the actual problems discussed concerned the methodology of experimental attempts to obtain reliable judgments based upon sensory evidence, and of their presentation in some numerical form, when the persons who make the judgments are also those who interpret the evidence

Papers were presented by Dr D Richards, of the General Post Office Engineering Department, on the "Design and Analysis of Subjective Acoustical Experiments which involve a Quantal Response" , by Dr R Harper and Dr G W Scott Blair (National Institute of Dairying) on "The Subjective Assessment of Deformable Materials and of Food Products" , by Dr R G Hopkinson (Building Research Station) on "The Multiple Criterion Technique of Subjective Appraisal", and by Dr E C Bate-Smith and A S C Ehrenberg (Low Temperature Research Station, Cambridge) on "The Operation of Laboratory Taste Panels"

The general discussion was opened by Dr N H Mackworth, who was followed by a considerable number of other nominated speakers, and these by an open debate which was carried on with very great vigour

In the course of the afternoon, almost all the known psycho-physical methods were described, and illustrations of their alleged highly successful use were plentiful and varied Dr Hopkinson made a new and important point of method when he presented evidence to demonstrate that, if subjective judgments have to be made about the effects of a physical variable, more reliable results are secured if a limited number of criteria are used in succession instead of a single criterion

Points arousing the greatest amount of difference of opinion were (*a*) In discrimination experiments, is it better to allot control of the physical variables to the subject, or to the experimenter, or to a third person ? (*b*) Do threshold determinations, whether absolute or relative, throw any light upon subjective assessments of complex groups of stimuli ? (*c*) Do experts produce any better results from a general operational point of view than a random population, and are repeated experiments any better than a 'once-for-all' trial ?

Two questions received inadequate notice (i) The suggestion, made by Dr Mackworth, that whenever possible performance criteria should be made to supplement direct subjective assessment received scant attention This, in fact, is one form of the very difficult problem of the relationship between reliability and validation with which sooner or later everybody who makes use of subjective assessments must come to terms But there was a persistent disposition to side-step this whole difficulty (ii) The justification and types of statistical analysis and interpretation that are available, or should be considered, for dealing with arrays of data of the subjective assessment order were less considered than might have been expected

In the end, Dr Bate-Smith suggested that the conference seemed to be divided between those who say "You can't" and those who assert "We must" Perhaps, though he did not say so, he would favour some revision of the Emersonian dictum into a form such as

When Theory whispers low "You can't"
Practice replies "I must"

And that is what most people seemed to think

F C BARTLETT

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# BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

## SECOND RESEARCH PANEL MEETING

THE second meeting of the Research Panel of the British Gelatine and Glue Research Association, held at Beale's Restaurant, Holloway Road, London, N 7, on October 12, was attended by representatives of member firms, of research associations interested in the uses of gelatine and glue, and of the Department of Scientific and Industrial Research The Research Panel meetings are intended to give an opportunity for interchange of scientific and technical information in the industry by the reading of papers followed by discussion

In the morning session, Dr J H Bowes, of the British Leather Manufacturers' Research Association, read a paper on "The Composition of Skin and the Changes Produced by the Action of Alkalis", describing, in the main, the work she has carried out in the past few years Dr Bowes first discussed the composition of skin, pointing out that, although collagen is the principal constituent, the remaining substances may have an important influence on the conversion of collagen to gelatin as well as on the tanning properties of the skin. Elastin fibres, reticular tissue, keratin, muscle fibres, sweat and sebaceous glands all occur, and, in addition, polysaccharides are present in small amounts.

Turning to the composition of collagen, Dr. Bowes reviewed the work which she, together with Prof. A. C. Chibnall and his collaborators, have done on the amino-acid composition of collagen. The collagen was specially prepared with minimum modification of the skin used. The results showed that almost the entire amino-acid composition is accounted for, and that cystine and tryptophan are absent. Dr. Bowes pointed out the relation between the titration curve obtained with collagen and its composition, and considered the modifications which occur when collagen is treated with alkali for prolonged periods. The most important reaction is the hydrolysis of the amide groups, with the production of ammonia. In addition, the swelling of collagen under alkaline conditions cannot be adequately interpreted unless a loss of cohesion is postulated. A lively discussion followed the paper.

The afternoon session consisted of a paper by the director of research of the Association, Mr. A. G. Ward, on "Recent Studies of High Polymers in Relation to the Properties of Gelatine and Glue". Mr. Ward described the methods which have enabled quantitative data to be obtained for high polymers. The importance of the non-uniformity of the molecular weight of gelatin was stressed, and the significance of the various forms of average molecular weight was discussed. Experimental methods were described which have been successfully applied to gelatin, including osmotic pressure, surface pressure and the ultracentrifuge. Further aspects of high polymers which were outlined were the theory of degradation of polymer chains and the origin of rubber-like elasticity. Results already obtained for gelatin by such workers as Scathard, Pouradier and Ferry were described.

# CHEMISTRY AT UNIVERSITY COLLEGE, DUNDEE

DURING the past three years the Chemistry Department of University College, Dundee, has been enlarged, renovated and re-equipped. On October 23 the new building was formally opened by Lord Burghley, rector of the University of St. Andrews. Sir James Irvine, vice-chancellor and principal of the University of St. Andrews, introduced Prof. N. V. Sidgwick, formerly professor of chemistry in the University of Oxford, who delivered an address. After the ceremony, Lady Burghley laid the foundation stone of a new science building which will house the Department of Electrical Engineering and the Department of Botany at Dundee.

The original chemistry laboratory at Dundee was built in 1883. It followed the German nineteenth-century style, having been modelled, like those of the Imperial College of Science and Technology, London, and of Owens College, Manchester, on Hofmann's laboratory at Bonn. At that time the Dundee laboratory ranked among the best-equipped in Great Britain, and was unique in its air-conditioning system which had been designed by Thomas Carnelley, the first professor at Dundee, along lines which have now become standard engineering practice. The building was added to in 1888, and the original plan was completed in 1905. Apart from some internal renovation in 1925, the Department has remained largely unchanged for nearly fifty years.

A storey has now been added, and the whole building has been completely renovated and re-serviced. The new floor provides two teaching laboratories, four organic chemistry research rooms and a glassblowers' workshop. The basement rooms vacated by the organic chemists have been converted to physical chemistry research laboratories. The two new teaching laboratories are each designed to accommodate thirty-two students comfortably; one will be used for teaching organic chemistry to second- and third-year students, while the other is shared between inorganic and physical chemistry teaching at the same level. The servicing of the building has been renewed and now includes all the usual piped services (gas, hot and cold water, compressed air and live steam) with a selection of electrical services (415 V three-phase A.C., 240 V A.C., 240 V D.C. and 50 V D.C.). The building is steam-heated and air-conditioned throughout.

In addition to the rebuilding, the Department has been extensively re-equipped. The research facilities have been extended to cover most important modern techniques in both physical and organic chemistry with the object of enabling problems to be studied using several different experimental methods. The work of the laboratory is at present concentrated mainly on the thermodynamics of solutions and adsorbed phases, electrochemistry, free-radical reactions and their relevance in polymer chemistry, acid-base catalysis, stereochemistry and problems of optical activity, together with general problems of reactivity of organic molecules. Furthermore, a full range of optical and spectroscopic techniques will shortly be available to supplement purely thermodynamic measurements. A well-equipped workshop and glassblowers' shop are making important contributions to these developments. It can now be fairly claimed that University College, Dundee, has a Chemistry Department which, for its size, is again among the best-equipped in Great Britain.

A conversazione was held on the afternoon of October 23, followed by the formal opening. Visitors were able to see a variety of research work in progress, demonstrations of the experiments used in the teaching laboratories, and a series of lecture demonstration models. Lord Burghley and the other guests, including representatives of Scottish universities and chemical industry, and past students, were welcomed by Prof. D. H. Everett, who referred to the difficulties which had been overcome in carrying through the reconstruction while the laboratory was in full use for both teaching and research. In a few words Lord Burghley declared the renovated building open.

Prof. Sidgwick began his address by mentioning the past holders of the chair of chemistry in University College, Dundee, since the foundation of the chair in 1882. Thomas Carnelley was professor for only six years and would, had he lived, have risen to a very high position in science. Percy Faraday Frankland, who in the field of chemistry was the distinguished son of an even more distinguished father, held the chair in Dundee during 1888–94; he then moved to Birmingham—and, incidentally, built there a laboratory closely resembling the one he left behind He was followed by James Walker, much of whose best scientific work was done in Dundee before he moved to Edinburgh in 1908 Hugh Marshall's tenure of the chair was cut short by his untimely death in 1913 Alexander McKenzie, whose contributions to stereochemistry gained him world-wide reputation, was professor in Dundee during 1914–38 He was followed by W F K Wynne-Jones (1938–47) and later by the present holder, Prof Everett

The increased facilities in Dundee for the teaching of chemistry and for research should benefit three classes of the community the students in general, the research workers and chemical industry Referring to the first group, Prof Sidgwick stressed the purely educational value of chemistry and also the importance of teaching it as an experimental subject Compared with the very simple apparatus available in his youth, that in use to day might seem elaborate, but Prof Sidgwick commented that, although really good men got valuable results with very limited accommodation, their work would have been still better had they had more space and better equipment Modern techniques have opened up new fields of investigation which must be available to our students if they are not to be seriously handicapped in their research

The relationship between universities and chemical industry was dealt with by Prof Sidgwick in some detail Up to the end of the past century the great majority of chemical manufacturers did not believe that science could help them, to-day almost every chemical firm has a research department It is therefore of the greatest importance that adequate numbers of trained chemists should be provided by universities, but Prof Sidgwick was apprehensive of the danger that, by offering large salaries, industry might now attract away many of the best research students and teachers and so cut down the supply of trained scientific workers

On the closer link between industry and the universities, Prof Sidgwick commented on the much more liberal attitude now adopted by an increasing number of firms Money is now often given to laboratories and research students without restriction on the research problems to be engaged upon, and with complete freedom of publication This is most satisfactory, but a difficult problem still remains in connexion with consultant work carried out by members of university staffs While agreeing that this is beneficial both to methods of production and to the consultant's pocket, Prof Sidgwick feared that it might also interfere with the teaching and research activities in the university There seems to be no general solution of this problem, which is clearly one which has to be treated in each case individually

D H EVERETT

# MEMBRANE PERMEABILITY

AT the annual meeting of the Society of Leather Trades' Chemists, held during September 22–23 in the University of Leeds, the fourth Procter Memorial Lecture was delivered by Prof E K Rideal, who chose as his subject "Membrane Permeability" Prof Rideal, professor of chemistry in King's College, London, began by reminding his audience that natural membranes of animal origin contain proteins and lipoids, the bacteria contain mucoids and magnesium ribonucleate, and the plants, cellulose The physiologist attempts to explore the nature of natural membranes *in vivo*, while the physico-chemical approach is to make models and find which one behaves most naturally The monolayer technique reveals that membranes behaving as osmotic barriers must be multimolecular in thickness

Three different types of membranes are recognized the so-called sieve or capillary membrane, the lipoid or oil membrane, and the membrane consisting of a polymer The problem of permeability has been attacked by direct passage, by osmotic and by E M F methods. Each has contributed some information of value Capillary membranes may consist of relatively large pores, as in aggregations of particles of different sizes, of laminar sheets, as in charcoal, or even of molecular pores, as in the zeolites

The interest of the investigator is in tube areas and lengths, the latter involving a tortuosity factor The Kozeny–Carman treatment of void fraction and surface area neglects in vapours the surface flow along the capillaries In liquid flow, application of the Kelvin equation leads to the assumption of an immobile adsorbed layer of liquid The work of Michaelis on the E M F across sieve membranes has been reinterpreted by Meyer and Teorell in terms of two Donnan restraints on each side of the membrane and a number of fixed charges inside the membrane

The permeability constant $P$, that is, the number of c c at N P T of gas passing in 1 sec through 1 sq cm of thickness 1 mm, is the product of the diffusion constant $D$ and the solubility constant $S$ The former may vary as the membrane concentration of dissolved vapour changes The permeability of polymer membranes is determined by the number of Eyring holes in the membrane capable of holding molecules of the penetrant, and the movement through the membrane is determined by the micro-Brownian movement of the non-crystalline chain segments of the polymer Movement is thus a property of the polymer, the permeation process requires an energy of activation and is not a free diffusion, solute molecules suffer a large change in entropy when 'dissolved' in a polymer, that is, they are rather tightly held The micro-Brownian movement of the chain segments likewise involves consideration of the ratio of fringe to micelle in the 'fringed micelle' type of polymer Some penetrants can peptize the micelles, others cannot do so If such a polymer membrane is expanded by solvent or plasticizer, it passes over into the capillary-type, which has already been discussed

The oil type of membrane seems to bear the closest analogy to natural membranes, which may consist of a lipoid-like material held in an open network of cellulose, or in the form of a lipoid lipo-protein complex mosaic The reactions at the interface between the membrane boundaries and the homogeneous phases can be studied by the monolayer technique, here the control of the mechanism of chemical reactions by surface tension changes, as well as the phenomenon of penetration, are all-important While the electrometric work of Beutner and his colleagues represents, in the main, non-equilibrium conditions, it is important to study the rate of transfer of solute across the boundaries by direct as well as electrochemical means The data obtained in this way bear a close resemblance to those natural cell walls which have been investigated

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Effect of Dextran of Various Molecular Sizes on Erythrocyte Sedimentation Rate

When dextran is mixed with blood an increase in erythrocyte sedimentation rate, due to aggregation of red blood corpuscles, is observed. In Sweden[1,2] and in Great Britain[3] it has been shown that this effect is greater with larger molecules (at least within the range of molecular weight 100,000–600,000), while with dextran of molecular weight less than about 60,000 there is no appreciable increase[3,4] in erythrocyte sedimentation rate. We have carried out experiments to establish these relationships on a quantitative basis.

The method involved mixing known concentrations of dextran in 0·9 per cent sodium chloride with fresh defibrinated human blood from normal volunteers. The final concentration of red blood corpuscles in the mixtures was maintained at definite values, in these experiments corresponding to a hæmatocrit of 30 per cent, and the concentration of serum was 35 per cent of the supernatant fluid. Erythrocyte sedimentation was observed in vertical Wintrobe tubes, 100 mm. in length and 3 mm. internal diameter, at a temperature of 25° C., readings being taken every five or ten minutes for at least ninety minutes. The maximum rate of sedimentation[5] was derived graphically from these data. The relative viscosity and specific gravity of each dextran–serum mixture and the specific gravity of each blood, serum and dextran–serum mixture (making calculation of erythrocyte specific gravity possible) were determined respectively by microviscometer[6] and the copper sulphate method of Van Slyke[7]. The maximum rates of sedimentation were then corrected to a standard relative viscosity (1·8), and a standard specific gravity difference between erythrocytes and serum mixture (0·066), the result being referred to as 'corrected maximum sedimentation velocity'.

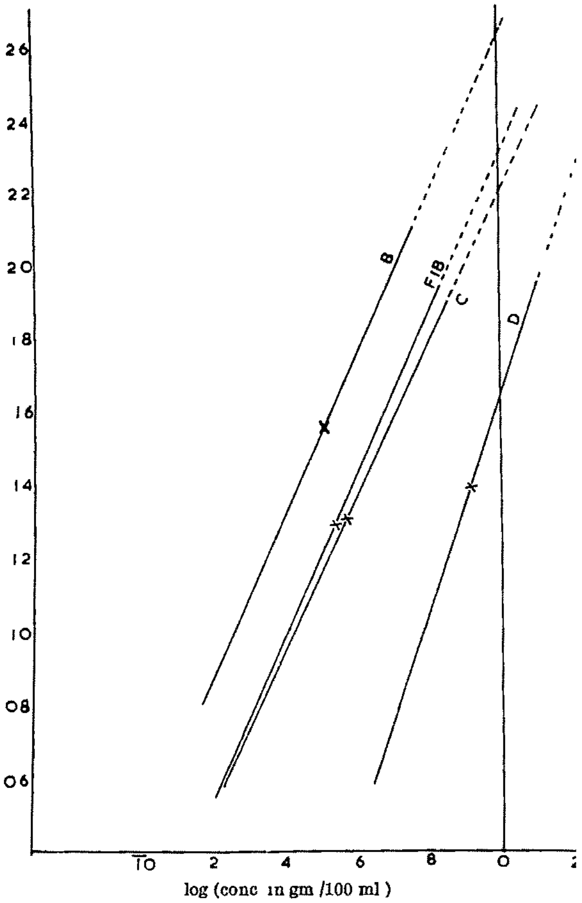
$$\text{Corrected maximum sedimentation velocity} = V_{mc} = \text{observed maximum rate} \times \frac{\text{observed relative viscosity}}{1\cdot8} \times \frac{0\cdot066}{\text{observed specific gravity difference between cells and serum}}$$

The dextran used was prepared by solvent (acetone)-precipitation from special hydrolysates of *Leuconostoc mesenteroides* cultures.

The range of molecular weight within each preparation was kept as small as practicable. The samples were characterized by calculation of intrinsic viscosities from determinations of relative viscosity at two concentrations between 0·5 and 1·5 per cent in each case. An indication of the mean molecular weights can be derived from the intrinsic viscosities on the basis of the ultracentrifuge studies of Ingelman and Halling[4].

Table 1

| Preparation | Intrinsic viscosity | Mean molecular weight |
|---|---|---|
| *B* | 0·54 | 700,000 |
| *C* | 0·36 | 220,000 |
| *D* | 0·28 | 124,000 |



Relationship between corrected maximum sedimentation velocity and concentration of macromolecules added to constant erythrocyte, serum–saline mixtures (30 per cent erythrocytes in each case). *B*, *C*, *D* indicate dextrans *B*, *C*, *D* respectively, and *Fib* human fibrinogen

$V_{mc}$ was then determined in duplicate for at least four concentrations of each dextran preparation. It was discovered empirically that a linear relationship existed between log ($V_{mc}$) and log (concentration of dextran) (see graph).

Statistical analysis shows these regressions to be highly significant, with no significant departure from linearity.

Clearly, log ($V_{mc}$) $\doteq$ log $K$ + $b$ log (conc.), and $b$ is independent of the molecular weight of dextran used, corresponding approximately to 2·17 in these experiments. $K$, which corresponds to the corrected maximum sedimentation velocity in 1 per cent of the dextran preparation, increases with the molecular weight of the dextran preparation employed. Equally satisfactory linear relationships were obtained with mixtures of the dextran preparations, $K$ in this instance being a resultant of those of the respective dextrans employed in proportion to their concentrations.

Similar experiments have been carried out using fibrinogen solutions in place of dextran (see graph). With equivalent erythrocyte concentrations, the values of $b$ obtained with fibrinogen are similar to those shown for the dextran preparations, $K$ being close to that found for dextran $C$.

The raised erythrocyte sedimentation rate found in various diseases depends in varying degree upon a rise in fibrinogen and on other asymmetric macro-

Table 2

| Substance | Concentration range | No. of observations | Regression ($b$) | $\sigma_b$ | Log $K$ ($y$ when log $x = 0$) | $\sigma_{\log K}$ |
|---|---|---|---|---|---|---|
| Dextran *B* | 0.170–0.565 gm. per cent | 32 | 2.147 | ±0.072 | 2.61 | ±0.038 |
| Fibrinogen | 0.158–0.752 gm. per cent | 10 | 2.197 | ±0.113 | 2.29 | ±0.073 |
| Dextran *C* | 0.170–0.700 gm. per cent | 8 | 2.046 | ±0.156 | 2.19 | ±0.170 |
| Dextran *D* | 0.382–1.360 gm. per cent | 8 | 2.406 | ±0.190 | 1.63 | ±0.037 |

molecules in patients' sera[8,9]. The quantitative evaluation of these different factors will be the subject of a full communication.

We are indebted to the Medical Research Council for financial support and to the Lister Institute and Messrs. Dextran, Ltd., for gifts of material.

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## Effect of Aureomycin on *Trichomonas intestinalis hominis*

During studies of aureomycin in human amoebiasis, we observed a remarkable side-effect in those patients who simultaneously harboured *Trichomonas intestinalis*. Before treatment, these flagellates were present in small numbers only; but they increased considerably after the administration of 3–4 gm. of aureomycin. This increase continued during treatment lasting seven to ten days and was not dependent on the consistency of the stools before or during treatment. In three out of the eight cases observed the increase was enormous; examination of these stools gave the impression of a pure culture of *Trichomonas*. Though it is known that *Trichomonas intestinalis* may appear in large numbers in the convalescent stage of bacillary dysentery (Manson-Bahr), it is less frequently observed in amoebic dysentery. We consider the regularity of the increase in eight cases and the enormous numbers occurring in three cases as particularly noteworthy.

Two possible explanations are suggested for this increase: (1) aureomycin may have caused a change in the bacterial flora of the intestine, making this milieu more congenial for the propagation of *Trichomonas*; (2) aureomycin may have exerted a specific growth stimulation on the flagellates. Such an effect was not observed on *Chilomastix* or *Lamblia*, which remained uninfluenced by this drug.

Studies on the effect of aureomycin on the intestinal flora will be reported shortly, and we are continuing to study the influence of this drug *in vitro* on *Trichomonas intestinalis*.

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## Effect of 2,4-Dinitrophenol on Osmoregulation in Isolated Kidney Slices

Stern, Eggleston, Hems and Krebs[1] reported that slices of a number of guinea pig tissues swelled in isotonic solutions under anaerobic conditions. They suggested that the fluid balance of living tissues is not determined merely by physical forces, but by a mechanism dependent upon the supply of energy. Robinson[2] found that rat kidney slices swelled to a similar extent, mainly on account of an increase in the volume of intracellular water, when respiration was inhibited by small concentrations of cyanide. This swelling was reversed when the oxygen uptake recovered, as hydrogen cyanide distilled out of the medium. The water content of the slices varied inversely with their oxygen consumption over the whole range from normal respiration to complete inhibition. The amount of osmotic work required to maintain the water content of the slices as a steady state was calculated, and found to be proportional to their oxygen uptake. It was therefore suggested that the intracellular fluid was hypertonic, and that the normal volume and internal hypertonicity of the cells were maintained by active transport of water outwards across the cell membranes at the expense of energy directly derived from oxidation.

|  | No. of expts. | Respiration |  | Total tissue water |  |
|---|---|---|---|---|---|
|  |  | ($\mu$l./mgm./hr.) | ± S.D. | % | ± S.D. |
| Normal medium | 44 | 4.2 | 0.4 | 77.5 | 0.8 |
| ,, + $M/200$ cyanide | 8 | 0.4 | 0.15 | 84.2 | 0.9 |
| ,, + $10^{-4}$ $M$ 2,4-dinitrophenol | 13 | 4.6 | 0.5 | 82.6 | 1.0 |

In recent experiments, $10^{-4}$ $M$ 2,4-dinitrophenol was added to the isotonic medium in which adult rat kidney slices were respiring in Barcroft manometers at 38.5° C. In this solution the slices swelled almost as much as they did when their respiration was inhibited by cyanide, though their oxygen uptake, if anything, was slightly increased. The total water content of the slices, which serves as a measure of swelling, is shown in the accompanying table. Respiratory rates are expressed in $\mu$l. of oxygen per hr. per mgm. initial moist weight of tissue. The smallness of the effect of 2,4-dinitrophenol upon the oxygen uptake may be explained by the observation of Dodds and Greville[3] that 2,4-dinitro-*o*-cresol did not increase the oxygen uptake of rat kidney slices in a phosphate-buffered medium such as was used in the present experiments, though it greatly increased respiration in a medium containing bicarbonate and lactate.

The dissociation of active osmoregulation and respiration by a concentration of 2,4-dinitrophenol which has been found to uncouple phosphorylation from oxidation[4] suggests that osmotic work performed by the cells in maintaining their normal water content is carried out through the mediation of phosphate bond energy

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## Production of Stippled Erythrocytes *in vitro*

THE punctate basophilia in erythrocytes occurring in association with lead poisoning has been interpreted in different ways and its origin still remains unknown Since the various interpretations have been thoroughly dealt with in several text-books and monographs[1-4] they will not be repeated here It must be emphasized, however, that disagreement exists as to whether punctate basophilia originates in the immature erythroblasts of the bone marrow[5] or in the circulating red cells Neither is it known whether stippled erythrocytes merely represent altered reticulocytes or polychromatic, that is, young erythrocytes

No studies appear to have been carried out to detect whether the direct action of a lead medium upon erythrocytes *in vitro* may cause basophile stippling For this purpose we suspended normal rabbit erythrocytes in plasma from rabbits suffering from severe lead poisoning

The experimental rabbits were poisoned with litharge (PbO) by daily intravenous injections of 0 25 gm of litharge (suspended—partly dissolved—in 10 ml water at 32° C) Their blood picture was followed by hæmoglobin determinations and by counting the erythrocytes, leucocytes, reticulocytes, and basophile stippled cells Reticulocytes were counted in moist preparations, after staining with a 0 1 per cent solution of Brilliant Cresyl Blue Stippling was determined partly in May-Grunwald-stained smears, partly by the method described by Helge Lund[6] In the course of five to eight days, the poisoned rabbits developed stippled cells in considerable numbers (10–20 per cent) Like previous workers[2], we found that, although the poisoning persisted, the number of stippled cells decreased again, returning to normal values shortly before death (Table 1) No relation could be found between the number of reticulocytes and stippled cells Neither does the degree of poisoning appear to bear any relation to the number of basophile cells

Table 1

| Experimental period (days) | Hb % | Erythrocytes | Reticulocytes ($^{0}/_{00}$) | Stippled cells ($^{0}/_{00}$) |
|---|---|---|---|---|
| 0 | 92 | 5 12 | 23 | 5 |
| 2 | 87 | 5 00 | 23 | 27 |
| 4 | 84 | 4 88 | 29 | 68 |
| 6 | 84 | 4 32 | 27 | 133 |
| 8 | 79 | 4 12 | 38 | 205 |
| 10 | 81 | 4 26 | 33 | 151 |
| 12 | 77 | 4 09 | 30 | 42 |
| 14 | 72 | 4 00 | 39 | 20 |
| 16 | found dead | | | |

Table 1 shows the fluctuations in the number of reticulocytes and of stippled cells during the course of lead poisoning in a rabbit receiving an intravenous injection of 0 25 gm of litharge daily

When the rabbits had received the poison for eight days, 20 ml of blood was drawn from a vein The above-mentioned values were determined, after which the blood was centrifuged (15 min, 1,500 r p m) To the plasma so obtained, washed blood cells from a normal rabbit were added and the specimen was placed in a water-bath of 37° C for four hours During this process, 'Carbogen' was passed through the samples This provided them with oxygen and prevented sedimentation At the end of four hours, reticulocytes and stippled cells were counted

Control experiments were carried out with normal erythrocytes and normal serum Table 2 gives the results of five experiments

Table 2

| Normal erythrocytes suspended in Plasma from 5 normal rabbits | | Normal erythrocytes suspended in Plasma from 5 rabbits poisoned with litharge | | Blood of the rabbits with lead poisoning | |
|---|---|---|---|---|---|
| Stippled cells ($^{0}/_{00}$) | Reticulocytes ($^{0}/_{00}$) | Stippled cells ($^{0}/_{00}$) | Reticulocytes ($^{0}/_{00}$) | Stippled cells ($^{0}/_{00}$) | Reticulocytes ($^{0}/_{00}$) |
| 7 | 19 | 139 | 21 | 205 | 39 |
| 5 | 27 | 112 | 25 | 170 | 43 |
| 3 | 25 | 100 | 20 | 138 | 27 |
| 6 | 31 | 56 | 39 | 78 | 25 |
| 6 | 20 | 107 | 25 | 151 | 38 |

It will be seen from the experiments, all of which point in the same direction, that stippling may be induced in normal cells cultivated *in vitro* in a medium which conditions stippling *in vivo*

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## Influence of Histamine and Acetylcholine on Nerve Block due to Procaine

IN a previous communication[1], experiments on nerve-muscle preparations were reported, showing that histamine is able to restore conduction in a nerve, blocked by procaine, even though procaine is still present These experiments have now been confirmed by action potential studies In a typical experiment the central part of a frog ischiadicus nerve, from which the connective tissue sheath had been carefully removed, was placed in a phosphate Ringer solution containing 0 05 per cent procaine hydrochloride The solution was adjusted to $p$H 7 3 in the presence of 6.5 per cent carbon dioxide. The nerve was stimulated with a break shock every second, and every spike was photographed. Total block occurred after 9.6 min. Then, without moving the nerve from the electrodes, this solution was replaced by a similar solution, containing 0.05 per cent procaine hydrochloride and 0.5 per cent histamine dihydrochloride, also adjusted to *p*H 7.3. Recovery began almost immediately, and in 1.9 min. the spike area was 72 per cent of the value at the onset of the experiment. This seemed to be the maximal effect.

In exactly the same way, a solution of 0.05 per cent procaine hydrochloride, containing 0.5 per cent acetylcholine and a trace of eserine[2], is able to restore a block caused by 0.05 per cent procaine hydrochloride. However, this effect seems to occur more slowly. In a typical experiment the spike disappeared in 6 min. with procaine, and a maximal recovery was reached in 25 min. with procaine plus acetylcholine. The area of the spike was then 57 per cent of the starting value.

The fact that the action potential is not completely restored indicates the possibility that not all the fibres are capable of being restored. During recovery, the action potential often shows a double peak which indicates the presence of fibre groups of different conduction velocity. When recovery is maximal, the spike again shows only one peak. It seems to be of importance that the nerve should be used soon after removal from the animal. Further studies on these problems are in progress.

*Note added in proof.* Since the above communication was written, a letter by Drs. Cabrera and Thompson[3] has appeared. They state that the deblocking effect of histamine reported by Bárány and Nordqvist is due only to a change in *p*H. The experiments have therefore been repeated with improved apparatus, where it is possible to measure *p*H in the nerve bath proper. The deblocking action was independent of any shift of *p*H.

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## Chloromycetin Resistance in *E. coli*, a Case of Quantitative Inheritance in Bacteria

DRUG resistance in bacteria has been investigated genetically in several cases, since Demerec began with penicillin resistance in *Staphylococcus aureus*[1]. The proposal to distinguish two classes of drug resistance—those in which the top level of resistance can be obtained in a single step, and those in which it can be acquired only gradually—has clearly a practical importance; its theoretical meaning has not been entirely elucidated, since genetical analysis has several limitations in bacteria. In fact, while mutational patterns are open to investigation in most cases, crossings can only be regularly undertaken, as in Lederberg and Tatum's original discovery[2], in a few strains of *E. coli*. In one of these, *E. coli K*-12, some work on the genetics of drug resistance has been carried out, the most extensive investigation relating to streptomycin. Full resistance in *E. coli* is developed in a single step[3,4].

Besides resistance, dependence is known, whereby some resistant mutants fail to grow in absence of streptomycin. Full streptomycin-resistance and dependence[4,5] seem to be due to a single locus (or closely linked loci). Further, Lederberg introduced resistance to azide[6] as a genetic marker; here a single step brings about a moderate degree of resistance, and the determining factor has been mapped, not only in this laboratory but also independently in two other laboratories, and found to be about midway between $V_1$ and $TL$ on the 'chromosome map' of *E. coli K*-12. Nitrogen mustard resistance was found to be gradual or abrupt in increase in different experiments, only a moderate degree of resistance being acquired, which made a detailed analysis difficult. In *E. coli K*-12 nitrogen mustard resistance is not accompanied by higher resistance to radiations, as in the case of *E. coli* B.

Completely 'gradual' increase of resistance has been found in the case of chloromycetin in *E. coli K*-12. Selecting for chloromycetin resistance by serial transfers in liquid cultures containing increasing concentrations of the drug (on a geometric scale), a rapid and relatively smooth increase of resistance is observed. Starting from a tolerated level of 5–10 μgm./ml., as is usual with strains derived from the original *E. coli K*-12, levels of resistance as high as 1,280 μgm./ml. (which is not far from the solubility limit of chloromycetin) can be obtained. The increase in resistance is twofold or lower, on the average, at every transfer. Resistance is relatively stable on repeated subculture in the absence of chloromycetin.

The smoothness of increase of resistance might constitute a *prima facie* case for non-genetical adaptation; if, on the other hand, adaptation is genetical, a relatively large number of genes should be found affecting chloromycetin resistance, assuming that it is to be accounted for by known genetical mechanisms.

A cross was made between a *W* 677 strain $(T\text{-}L\text{-}B_1\text{-}Lac_1\text{-}V_1^r\ Mal_1\text{–}\ Gal_1\text{–}\ Xyl\text{–}\ Ara\text{–}\ Mtl\text{–})$ which had been grown with 640 μgm./ml. chloromycetin in broth, and a fully sensitive 58–161 strain $(B\text{–}M\text{–})$. Crosses were made with the usual technique introduced by Lederberg and Tatum[2]. By this technique, recombinants are selected out of a mixture of parental cells using 'fixed' recombination markers, in this case capacity of growth in absence of given growth factors. Strain 58–161 can grow in the absence of threonine, leucine, vitamin $B_1$, which are needed by *W* 677 for growth; strain *W* 677 can grow in absence of biotin and methionine which are needed for growth by 58–161. Plating the mixture of the two strains on minimal medium, where such growth factors are not supplied, parental cells will not develop, while recombinants of the right type can develop into visible colonies. The two strains differ by a number of other markers, lactose fermentation (absent in *W* 677, present in 58–161), reaction to virus $T_1$ ($V_1^r$ indicating resistance in *W* 677, while 58–161 is sensitive), etc., as indicated by the other symbols.

Such differences can be used as 'free' recombination markers in that they are not directly selected for or against in the minimal agar plates, and their segregation in the recombined colonies is used to build a 'chromosome map'[7]. The relative order of the genes which have been 'mapped' satisfactorily, and which are relevant for this and other crosses conducted during the present work, is as follows:

$B_1$-($B$,$M$)-$V_6$-$Lac_1$-$V_1$-$Az$-($T$,$L$), where $V_6$ refers to virus $T_6$ resistance, $Az$ to azide resistance

Recombinants between the chloromycetin-resistant *W* 677 and sensitive 58–161 showed a scatter from full sensitivity to nearly full resistance, the resistance of each recombinant being roughly proportional, on the average, to the length of the chromosome segment which—as could be inferred from recombination markers—given recombinants got from the resistant parent A closer analysis shows one and possibly two loci for resistance in the segment between *BM* and *Lac*, one locus at least between *Lac* and $V_1$—there is evidence that other loci, too, must take part in building full resistance These data are therefore consistent with the hypothesis of many loci with cumulative action

First-step resistants, obtained by both plate and test-tube selection methods, were analysed in crosses of sensitive with resistant and resistant with resistant, and they showed a clear-cut segregation of sensitivity or resistance, within experimental error Mapping loci of first-step resistance, the locus most frequently met so far was closely linked to $V_6$ In this way, a cross with four free markers between *BM* and *TL* (fixed recombination markers) was made, involving chloromycetin resistance, $V_6$, *Lac* and $V_1$, giving a relatively satisfactory test of linearity of the chromosome region between *BM* and *TL* First-step resistants were also found which gave no resistant recombinants when crossed to sensitive, probably because of close linkage with fixed recombination markers (*BM* in this case) The interactions in resistance between different loci are under investigation at present In fact, this case seems to offer unusual possibilities of a detailed analysis of the interactions between genes in quantitative inheritance The stability of the drug is a factor of no little importance in facilitating quantitative work with chloromycetin

The *K*-12 strains used in this research have been kindly sent by Dr J Lederberg One of us (G A M) has been supported during this work by a grant from the Rockefeller Foundation

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## Modification of the Biochemical Responses of the Immature Pullet to Œstrogen by means of Dietary Aureomycin

The effects and roles of dietary supplements containing growth-factors and antibiotics have recently excited widespread interest among poultry nutritionists This interest prompted us to examine the effect of adding aureomycin to the diet upon the biochemical responses of the sexually immature pullet to œstrogen, and with reference to serum calcium and serum riboflavin in the first instance It is well known that the increase of serum riboflavin evoked by œstrogen is closely related to the increase in serum calcium[1], and hence to the concurrent increases in serum phosphoprotein and phospholipid. These responses may be secondary to the effects of œstrogen on liver activity and function[2] Furthermore, Hertz, Tullner and Dhyse[3] have shown that the magnitude of the response of serum riboflavin to œstrogen is, within limits, related to the level of riboflavin in the diet, a point which has been noted also in this laboratory[4]

In the light of these considerations, it seemed that aureomycin might conceivably influence the response of serum riboflavin and serum calcium to œstrogen in one or other of the following ways

(*a*) By reducing fixation or destruction of dietary riboflavin by the intestinal flora, while not modifying the responses of serum calcium, etc In this case, the serum riboflavin values corresponding to given serum calcium-levels should be higher in œstrogenized birds receiving aureomycin than in similarly treated birds not receiving aureomycin

(*b*) By reducing fixation or destruction of growth-factors by the intestinal flora generally, or possibly by reducing production of deleterious substances, in such a way that the liver response to a given dose of œstrogen is enhanced In this case, both the serum calcium and serum riboflavin of œstrogenized pullets receiving aureomycin should be higher than in similarly treated birds not receiving aureomycin

| | Group I | Group II | Group III | Group IV |
|---|---|---|---|---|
| No of pullets | 6 | 6 | 6 | 6 |
| Av initial live-weight (kgm ) | 0 64 | 0 62 | 0 65 | 0 61 |
| Av final live-weight (kgm ) | 0 90 | 0 87 | 0 90 | 0 86 |
| Total dosage of œstradiol benzoate (mgm ) | nil | nil | 6 × 1 0 | 6 × 1 0 |
| Total dosage of testosterone propionate (mgm ) | nil | nil | 6 × 0 5 | 6 × 0 5 |
| Aureomycin hydrochloride (mgm /lb food) | nil | 20 | nil | 20 |
| Oviduct weight (gm ) | 0 12 | 0 11 | 12 7 | 12 9 |
| Liver weight (gm ) | 18 0 | 15 9 | 20 5 | 20 9 |
| Serum calcium (mgm /100 ml )* | 11 3 | 11 1 | 34 7 | 49 0 |
| Serum riboflavin ($\mu$gm /ml )† | 0 03 | 0 04 | 1 03 | 1 85 |

* Difference between Group I and Group II not significant Difference between Group III and Group IV significant at $P = 0\ 05$ (least significant difference = 10 2)

† Difference between Group I and Group II not significant Difference between Group III and Group IV significant at $P = 0\ 05$ (least significant difference = 0 702)

Accordingly, four groups each of six immature cross-bred pullets (New Hampshire ♂ × Barred Plymouth Rock ♀) aged seven weeks were placed at random in individual cages and assigned at random to four different treatments (see table) The percentage composition of the diet was as follows maize meal, 30, barley, 20, oats, 10, wheat, 10, soybean meal, 16, fish meal, 3, meat meal, 3, skim milk powder, 2, dried brewer's yeast, 2, dehydrated alfalfa, 2, limestone flour, 2, rock phosphate, 1 0 To each 100 lb of this diet was added ½ lb salt, 11 4 gm manganese sulphate, 0 5 gm niacin, 3 gm riboflavin (Merck), 0 25 gm pantothenic acid and 100 gm fish oil (2,400 units vitamin A, 400 units vitamin $D_3$)

Groups I and III received the above diet Groups II and IV received the same diet supplemented with 20 mgm crystalline aureomycin hydrochloride (Lederle) per lb The food consumption was maintained equal as between all birds. The experimental period lasted twelve days. The oestrogen was given intramuscularly in six equal doses on alternate mornings.

The results show that the inclusion of aureomycin in the diet enhanced the response of *both* serum calcium and serum riboflavin to oestrogen. The effect was about the same as would have been the effect of injecting *c.* 10 mgm. oestradiol benzoate instead of 6 mgm., and the relation between serum calcium and serum riboflavin was not apparently disturbed.

It seems possible from this experiment that the addition of antibiotics to a reasonably adequate diet may modify its nutritional effects in such a way that the responsiveness of the pullet to parenteral oestrogen is enhanced. It follows that the responsiveness of the pullet to endogenous oestrogen may likewise be modified by inclusion of antibiotics in its diet. Further experiments would be necessary before attempting to relate this effect of aureomycin to the supply of vitamins $B_{12}$ available for protein-synthesizing functions[5] in the liver.

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## Folic Acid as a Growth-Factor for the Rat

THE recent publication by Aschkenasy-Lelu and Aschkenasy[1] of their findings on the effects of folic acid on growth and blood composition in the young rat on a synthetic diet with or without adequate protein has prompted us to record a note on some early observations made on folic acid as a growth-factor. As soon as crystalline folic acid became available for biological research in 1946, an experiment was planned to investigate the effect of folic acid on the growth of rats receiving a synthetic diet. Weanling rats of the black-and-white Lister Institute strain were given at 28 days of age a diet consisting of:

| | |
|---|---|
| Vitamin-free casein | 20 per cent |
| Sucrose | 60 ,, ,, |
| Hardened arachis oil | 12 ,, ,, |
| Lard | 3 ,, ,, |
| Salt mixture (McCollum 185) | 5 ,, ,, |

with 0·02 ml. cod liver oil daily and 1 ml. of a solution of B vitamins containing, per ml.:

| | | | |
|---|---|---|---|
| Vitamin $B_1$ | 10 μgm. | Vitamin $B_6$ | 10 μgm. |
| Riboflavin | 40 ,, | Pantothenic acid | 100 ,, |
| Biotin | 1 ,, | Nicotinic acid | 1 mgm. |
| Inositol | 1 mgm. | *p*-Aminobenzoic acid | 1 ,, |
| Choline chloride | 3 ,, | | |

Folic acid was administered separately in daily doses of 0, 0·5, 1·0, 2·0, 4·0 or 8·0 μgm. A positive control group of rats was given a crude liver extract in a daily dose equivalent to 6 gm. original liver.

In preliminary tests an extracted casein, which was of a dark yellow colour, possibly due to overheating in the drying process, was used and the animals did not grow satisfactorily except in the group receiving crude liver extract. The animals had poor coats and some showed reddish-brown staining of the fur and tail. No macroscopic evidence of liver or kidney damage was found when the animals were killed after seven weeks on the diet. Afterwards, more satisfactory samples of casein were obtained and all animals showed good weight increases during the first four weeks on the diet, with a decline in later weeks. The rats remained in good general condition throughout. The results of a typical experiment are given in the accompanying table.

WEIGHT INCREASES OF RATS RECEIVING A PURIFIED DIET WITH GRADED DOSES OF FOLIC ACID

| Dose of folic acid (μgm.) | Number and sex of rats ♂ | Number and sex of rats ♀ | Average weekly weight increases (gm. in 4-week period) | Average weekly weight increases (gm. in 7-week period) |
|---|---|---|---|---|
| 0 | 4 | 4 | 15·60 | 12·46 |
| 0·5 | 4 | 4 | 15·75 | 11·94 |
| 1·0 | 3 | 5 | 15·38 | 12·55 |
| 2·0 | 2 | 6 | 16·03 | 12·38 |
| 4·0 | 2 | 6 | 15·47 | 11·95 |
| 8·0 | 4 | 4 | 17·69 | 13·45 |
| Liver extract | 3 | 5 | 21·19 | 14·40 |

When the differences between the average growth-rates for the different groups were compared by Fisher's *t*-test, no significant differences were found except in the group having liver extract, which grew better than any of the others. This result was repeated in later tests, and it thus appeared that addition of up to 8 μgm. folic acid daily to the synthetic diet did not affect the weight increase in young rats. It was apparent from the preliminary tests that the nature of the casein component of the diet was of considerable importance in a highly purified diet.

These results are of interest in view of the relation which Aschkenasy-Lelu and Aschkenasy reported between the protein-level in the diet and the response to a daily dose of 50 μgm. folic acid. The numbers of rats in their experiments were small, but it seemed that only very small and irregular increases in average growth occurred when the dose of 50 μgm. folic acid was given with a diet containing 15 per cent casein. When there was 7 per cent of casein in the diet, administration of folic acid appeared to depress growth. Even with 20 per cent of casein in the diet for the present tests the growth response was poor if the casein was not of good quality. It would seem that folic acid is not an essential growth-factor for rats, and that other more important growth-factors present in liver extracts are required to supplement a purified diet. Further details of the study of growth factors are in the course of publication.

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## Nature of the Milk-Ejection Process

THE fact that extracts of the posterior lobe of the pituitary gland will cause expulsion of milk from the mammary glands of lactating animals has been known for some time[1,2] The suggestion that the oxytocic factor is involved in normal milk let-down was made by Ely and Petersen[3], though Turner had proposed a theory of milk ejection earlier[4] and with Cooper[5] presented evidence for the existence of a separate milk-ejection hormone This evidence was based on the use of a lactating rabbit as an assay animal, and showed that the milk-ejecting activity of whole pituitrin is greater than that of purified oxytocin for a given oxytocic activity, and that the purified pressor preparation is more active than it should be for its oxytocic content

Using the lactating sow as an assay animal and milking her by machine, I have confirmed the observations of Turner and Cooper on the milk-ejecting activity of commercial purified pressor preparation Through the generosity of Dr du Vigneaud, a sample of purified oxytocin assaying 500 oxytocic units per mgm was made available for milk-ejection assay This sample had been prepared by the method of Livermore and du Vigneaud[6] It had a milk-ejecting potency equal to its oxytocic activity The assay was based on two criteria, namely, the volume of milk ejected and the duration of the let-down action These results point to oxytocin being the let-down hormone. However, they also raise the problem of why commercial preparations of pressor hormone with an oxytocic content stated by the makers to be less than five per cent should have a milk-ejecting activity of about five times their oxytocic activity

The mode of action of the milk-ejecting hormone has in the past been assumed to be due to its acting on smooth-muscle fibres in the mammary gland MacFarlane[7] and Richardson[8] have demonstrated the existence of myoepithelial cells so distributed in the mammary gland as to provide a mechanism by which the milk-containing alveoli can be squeezed and the contents expelled into the collecting ducts These cells are also seen to run along the walls of the small ducts As these ducts will be closed by the pressure of the surrounding filled alveoli prior to milking, their contraction or attempted contraction should result in an opening of the lumen on the duct That such an opening may occur is suggested by the following evidence

(1) When let-down occurs in the cow there is a sudden large rise in gland cistern pressure This is followed by a small fall as the hormone is dissipated Should milking be attempted, say, ten minutes after let-down, only 60 per cent or so of the normal milk yield will be obtained unless there is another release of hormone The fall in pressure in the unmilked cistern is much smaller than it should be if the retained milk is held, due only to the alveoli relaxing and 'sucking back' the expelled liquid These observations have been made by a number of workers as well as during work at this laboratory

(2) In his studies on intramammary pressure at this laboratory, Mr Phillips[9] has shown that during the period of action of the let-down hormone, the milk cistern of the cow is connected to a constant-pressure source (such as contracting fibres around the alveoli). When the hormone goes out of action, the connexion to this constant-pressure source is broken.

(3) If, after let-down is evoked, sterile saline is run into the cistern of a cow to a pressure above that due to normal let-down, the injection of pituitary extract causes a fall in pressure No change or a rise in pressure would be expected if the only action of the milk let-down hormone is the compression of the alveoli

(4) In the case of the sow, which has no gland cistern, the flow of milk stops suddenly when the hormone is dissipated, almost as if a valve mechanism shuts when a certain threshold is reached

In the light of this evidence, it is suggested that when the let-down hormone acts on the mammary gland it not only causes a contraction of the myoepithelium around the alveoli, so causing an increase in pressure within the latter, but also causes an opening of the small ducts due to the tightening of the longitudinal myoepithelial structures surrounding them This causes a fall in duct impedance and a consequent rapid flow of the milk into the large ducts and the gland cistern

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## Milk Ejection following Electrical Stimulation of the Pituitary Stalk in Rabbits

CONSIDERABLE indirect evidence exists[1] for the involvement of the posterior pituitary gland in 'let-down' or ejection of milk Experiments were performed to find the effect of electrical stimulation of the pituitary stalk on the mammary glands in six lactating rabbits After overnight separation from their litters, the animals were anæsthetized with ether, and a single teat-duct was cannulated and connected to a kymographic volume-recording system A glass-insulated platinum wire electrode with 1 mm bare tip mounted on a stereotaxic instrument was used for stimulation A standard stimulus of 1 min duration was adopted with 1 0 volt, 50 cycles sine-wave alternating current

Following stimulation, milk was seen to flow up the cannula after a latent period of about 25 sec , reaching a peak at 90 sec , and thereafter gradually subsiding to the original level over 4–7 min The volume of milk ejected was 0 5–1 5 c c , representing approximately 1/48 of the total ejection volume, since there are six ducts in each teat Successive ejection responses were of diminishing magnitude, but as many as three responses could be elicited in a period of 30 min Intravenous injection of 200 mU posterior pituitary extract gave similar ejection responses with a latent period of 10–15 sec

These results offer strong support for posterior pituitary mediation of 'let-down' They provide no clue to the mechanism initiating the response , but recent evidence[2] suggests that the suckling stimulus activates the neurohypophysis in the normal unnaesthetized rabbit Experiments are in progress to tudy the effect of electrolytic lesions in the supra- ptico-hypophysial tract on 'let-down' in this species

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## Variation of the Somatic Chromosome Number in Man

THE necessity of stressing the importance of hromosomes in the organization of plants and nimals, and their decisive role in inheritance, caused Hertwig in 1918 to formulate the 'law of constancy f chromosome number', which implies that all cells f a given organism contain the same somatic number f chromosomes A great number of observations ave, however, shown that this concept is in need f revision Especially in insects[1,2] and in plants[3], t has been established that certain cells and even hole tissues may represent different degrees of olyploidy

It has been proposed that another type of variation ccurs in the somatic chromosome number of man isregarding authors whose cytological technique has een insufficient to warrant exact conclusions, we may take Karplus[4] and Andres and Jiv[5] as the first o produce evidence that the somatic cells in human mbryonic tissues contain variable, mostly aneuploid, hromosome numbers

That these findings, which are undoubtedly valid n the light of our present observations, have been ompletely overlooked in the cytological literature s, however, easy to understand First, it seems at irst sight to be impossible to bring them into agreement with the known rules of heredity and gene ction Secondly, human embryonic tissues are ather difficult to fix satisfactorily The figures in he earlier papers are consequently rather unconvincing Hence studies on human chromosomes as well as on other animals have been made mostly n germ-line cells, which naturally must contain the hromosome number characteristic of the species hirdly, chromosomes have been more extensively tudied in plants and lower animals Since in these—xcept for occasional polyploidy—the somatic cells eem to contain a constant chromosome number, it as naturally been inferred that the same must be rue of the higher animals also A final blow to ttempts to propose a variation in the somatic hromosome number in man was given by the uthority of Kemp[6], who maintained that they were ue to faulty observations

We were led to study the somatic chromosomes n man through our studies on the cytology of human ancer tissues[7–9] As normal comparison material the terine epithelium in its proliferation stage was hosen It was found that the cells in this tissue ad chromosome numbers showing a wide range f variation Timonen[9] counted the chromosome umber in a thousand cells The numbers varied etween 4 and 100, the highest peak lying at 20–25 hromosomes and another much lower at 45–50 hromosomes Measurements of nuclear volumes gave alues which were in good agreement with the varyng chromosome numbers

To discover whether the same condition obtains in other human tissues, embryonic tissues were studied cytologically Our material consisted of various tissues of fourteen human embryos aged six to twenty-four weeks It was found that all the embryonic tissues studied, including skin, brain, liver, intestine, cartilage, and bone marrow, had chromosome numbers varying from 12 to polyploids, the chromosome numbers most frequently encountered obviously lying between 20 and 30 No special number was characteristic for any kind of tissue Whether or not the peaks varied between different tissues cannot be decided from the present material Fig 1 represents the 20 somatic chromosomes from a brain cell in an eight-weeks embryo, while Fig 2 illustrates a somatic metaphase from uterine epithelium with 41 chromosomes

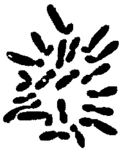

Fig 1

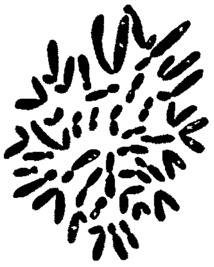

Fig 2

Fig 1 Somatic metaphase plate with 20 chromosomes from a brain cell of an eight-weeks embryo (× 3,000 )

Fig 2 Somatic metaphase plate with 41 chromosomes from the uterine epithelium (× 3,000 )

What the actual mechanism underlying the variation in the somatic chromosome number is, is not clear, since very early stages have not as yet been studied Whether the lagging chromosomes seen especially in the anaphase stages are able in themselves to bring about this phenomenon remains so far an open question

The most obvious problem is, however, how the variation in the somatic chromosome number is to be reconciled with the fact that heredity and differentiation in man obey the same laws as in those organisms in which every somatic cell contains the constant diploid chromosome complement To account for this, we must assume that the whole human organism, or at least the whole tissue, acts as one unit Let us assume an original cell with the complete chromosome complement necessary for the development of the organism, and that a tissue arises from this in which the cells contain different numbers and combinations of chromosomes (By what means this differential distribution is effected is not of importance in this connexion ) If we suppose that every individual chromosome has divided the same number of times, the relative number of the different chromosomes in the tissue remains the same as in the original cell For such a tissue in which the chromosomes are distributed differentially between the cells to act similarly to a tissue in which every cell contains the same number of chromosomes, we must assume that the chemical and physiological interaction between the cells is much closer than in lower animals In the lower organisms every cell would be a relatively independent unit, whereas the working unit in man would be the whole organism

We suggest tentatively that the same type of variation in the somatic chromosome number will be found to be characteristic of warm-blooded animals in general It does not seem impossible that it is just this property which determines the difference in the organization of plants and lower animals on one hand and of the warm-blooded animals on the other We may in this connexion recall, for example, the great capacity for regeneration of plants and lower animals as compared with higher animals, and the occurrence of both sex and other mosaics in plants and insects and their absence in warm-blooded animals

Our thanks are due to Prof A Turunen, head of the Women's Clinic of the University of Helsinki, for the opportunity of carrying out the present study A more extensive account of these observations and their theoretical implications will be published elsewhere[10]

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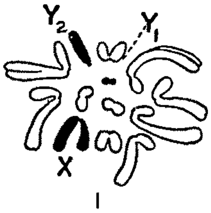
## Multiple Sex Chromosomes in the Marsupials

DURING the past thirty years, some twenty species of marsupials have been examined cytologically In all of them, a typical $XY$ sex-chromosome mechanism has been reported We have recently re-investigated the potoroo (*Potorous tridactylus*), a common species of rat-kangaroo in Tasmania. In the spermatogonial mitoses, the male shows thirteen chromosomes, whereas the female shows twelve in ovarian mitoses (Figs 1 and 2) The chromosomes of the female can easily be arranged in homologous pairs, one pair (the $X$-chromosomes) being conspicuous by their long, nearly median, centromere constriction In the male, ten chromosomes can be paired, but three have no similar partners These are the $X$, with a long submedian constriction, the smallest of the set ($Y_1$), and an acrocentric ($Y_2$) The last two chromosomes are not represented in the female In accord with thes observations, five bivalents held together by fro one to five chiasmata and a trivalent are formed a the first division of meiosis in the male (Fig 3) Th trivalent is made up of the $X$, pairing in one of i arms with $Y_1$, and in the other arm with $Y_2$ Orient tion on the spindle is always such that $Y_1$ and are directed to one pole, and the $X$ to the oth pole Two types of sperm are produced, a mal determining type with seven chromosomes, and female-determining with six The sex-determinin mechanism is, thus, of the $XY_1Y_2$ $XX$ type



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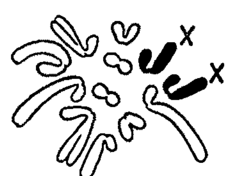

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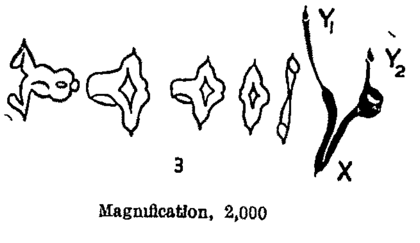

3

Magnification, 2,000

In the prophase stages of meiosis, the $Y_2$ and i homologous arm in the $X$ behave similarly to t autosomes and usually form two typical chiasmat The other arm of the $X$-chromosome, like $Y_1$, strongly heterochromatic, being condensed into a irregular sphere at earliest diplotene At later d plotene this arm is seen to be made up of two part the distal pairing segment being more condens than the intercalary unpaired region This b haviour is characteristic of the $X$-chromosomes other marsupials that have been investigated[1] is thus probable that the aberrant mechanism in t potoroo has arisen by translocation between t $X$-chromosome and an autosome with loss of centromere

These results are based on the examination of thr specimens, a male from Sorell in southern Tasman and a male and female obtained in Hobart T species has previously been investigated by Altman and Ellery[2] in animals obtained from Tasman They interpreted their observations as showing typical $XY$ mechanism It is, perhaps, possible th two sex-determination mechanisms exist in th species However, since their $XY$ bivalent corr sponds in size to the smallest bivalent of our materia this seems unlikely

It is at present impossible to say how widesprea multiple sex-chromosome mechanisms are in t marsupials As pointed out by Darlington[3] and mo recently by Matthey[4], Agar's[5] results on *Macrop ualabatus* (= *Wallabia bicolor*) are probably to interpreted as showing the existence of a multi mechanism in this species. Indeed, the $X$-chrom some seems to have the same long centromere co striction which is visible in the potoroo We interpr Agar's figures as showing that the female wallaby h ten chromosomes , and the male eleven, of whi three form a trivalent at meiosis as in the potoro It is probable that a similar mechanism may al exist in the insectivore *Sorex araneus*, Bovey (cit in Matthey[4]) having described a trivalent at meios in the male The chromosome number in the fema of this species is, however, unknown

We wish to thank Mr A G Lyne for assistance this investigation. The Fauna Board of Tasman kindly gave us permission to take specimens of th protected animal One of us was in receipt of Commonwealth Research Scholarship

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## Height to Node Ratio of Jute Plants

In an earlier communication[1], it was pointed out that, at the fruiting stage, the ratio of the height to the number of nodes of the two varieties of mung (*Phaseolus aureus* Roxb Syn , *Phaseolus radiatus* Linn ) plants, sown at different times of the year, lies always between 2 2 and 2 9, and that the total height and the number of nodes of the two varieties gradually became similar as the sowing was delayed from August until October

Calculations made from results obtained while studying the effect of sowing-time on the growth and development of two species of jute, *Corchorus capsularis* Linn (type D 154), and *C olitorius* Linn (type Chinsura Green), sown at an interval of thirty days from April to June (in case of the latter species, however, the first sowing was not done), in replicated plots in the field, showed very similar results The final observations and measurements, as well as the ratio of the height to the number of nodes, are shown in the accompanying table

| Date of sowing | *Corchorus capsularis* | | | *Corchorus olitorius* | | |
|---|---|---|---|---|---|---|
| | Height, *H* (cm ) | No of nodes (*N*) | *H*/*N* | Height, *H* (cm ) | No of nodes (*N*) | *H*/*N* |
| April 1 | 314 17 | 81 33 | 3 86 | — | — | — |
| May 1 | 331 25 | 88 30 | 3 75 | 360 67 | 107 66 | 3 55 |
| May 31 | 257 75 | 70 33 | 3 66 | 269 66 | 72 66 | 3 71 |
| June 30 | 193 00 | 55 00 | 3 50 | 188 70 | 51 33 | 3 67 |

The ratios of height to number of nodes with reference to the different time of sowing lie between 3 50 and 3 86 for *C capsularis* and 3 35–3 71 for *C olitorius* The difference between the highest and the lowest ratios is 0 36 in both cases, whereas for mung[1] it was observed that the difference was 0 7 in both varieties The ratio is correlated with the time of sowing only in the case of *C capsularis* The heights and the number of nodes of the two species, as in the case of mung[1], gradually became almost similar at the later sowings It has further been observed that the range of variation with regard to the ratio is greater during the early stages of growth of the plants than at the later stages

This work was done at the Botanical Laboratory, Presidency College, Calcutta A detailed paper has already been sent elsewhere for publication

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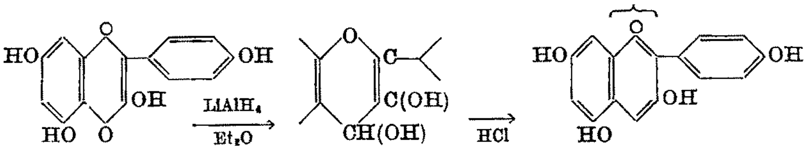
## Conversion of Flavonols into Anthocyanidins

Qualitative experiments with a wide range of γ-pyrones show that they are reduced by lithium aluminium hydride to γ-pyranols, which afford pyrylium salts on treatment with acids



Anthocyanidins are produced in this way from the appropriate flavonols Thus kæmpferol yields pelargonidin chloride, which was readily isolated, crystallized and identified

The process is a general one and naturally works well with methoxylated flavones, though protection of hydroxyl groups is not essential, it is also applicable to the reduction of xanthones to xanthydrols (thence to xanthylium salts) and to other γ-pyrones

The advantage of this method resides in the fact that pinacol-like coupling of the molecules is avoided Thus a paper chromatogram of the reduction product of kæmpferol showed that the pelargonidin was uncontaminated by related pigments The feasibility of reduction of flavonols should provide a new resource in the study of natural products because the flavylium salts have very characteristic properties

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## Preparation of Bicholestatriene from Cholesterylacetate

In a recent communication in *Nature*, Hafez[1] has described the isolation of a yellow bicholestatriene from the mixture of products obtained by the action of N-bromosuccinimide on $\Delta^6$-*i*-cholestadiene A compound of similar, if not identical, nature is also occasionally obtained as a by-product of the preparation of 7-dehydrocholesterylacetate from cholesterylacetate and N-bromosuccinimide according to the procedure of Bernstein *et al* [2]

In a typical experiment, 5 gm of cholesterylacetate was dissolved in 60 c c of petroleum ether (b p 60–70°) After the addition of 2 5 gm N-bromosuccinimide, the mixture was refluxed with stirring and illumination from an *RSP*-2 'Photospot' lamp placed 5 cm below the flask The reaction was accompanied by the evolution of some hydrobromic acid After four minutes, 2 55 c c of *s*-collidine was added to the reaction mixture, which was then cooled to room temperature and filtered The filtrate was concentrated *in vacuo*, and the oily residue dissolved in 30 c c of benzene containing 1 5 c c of *s*-collidine The solution was refluxed for twenty minutes and then cooled and washed successively with ice-cold aqueous solutions of hydrochloric acid and sodium carbonate and with water Removal of the solvent *in vacuo* afforded a dark oily residue which was dissolved in petroleum ether and chromatographed on a silica gel column Elution with benzene–petroleum ether (1 1) gave 400 mgm of a yellow material which after two crystallizations from benzene-ethanol melted at 241–244°, $[\alpha]_D^{25°} = -200°$ (found C, 88 54 , H, 11 54 per cent , molecular weight, 728 , calculated for $C_{54}H_{82}$ C, 88 70 , H, 11 30 per cent , molecular weight, 731) The ultraviolet absorption spectrum of this hydrocarbon in *n*-hexane shows maxima at 254 ($E$ = 12 400), 262 ($E$ = 13 400), 350 ($E$ = 40 200) and 368 ($E$ = 44 500).

It appears most likely that this hydrocarbon is identical with that described by Hafez, and that the mechanism of its formation does not necessarily involve the *i*-steroid structure

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## Change with Temperature of the Heat of Wetting of Dry Cellulose in Water, and its Bearing on the Specific Heat of the Adsorbed Water and of the Swollen Cellulose

THE heat of wetting of dry standard cellulose in water was measured at temperatures between 0° C and 40° C The cellulose and the experimental technique were those described previously[1] The heat of wetting decreases with the rise of temperature as shown by the following values, which represent the means of several experimental results at each temperature

| Temperature | Heat of wetting (cal /gm dry cellulose) |
|---|---|
| 0° C | 11 84 |
| 10 | 11 51 |
| 20 | 11 01 |
| 25 | 10 80 |
| 30 | 10 70 |
| 40 | 10 14 |

The decrease appears to be linear in the range tested, and amounts to about 0 042 cal /degree/gm cellulose

The heat of wetting represents the decrease in the heat content ($-\Delta H$) of the 'dry cellulose – water' system through the wetting process The variation of the change of heat-content with temperature represents the difference between the heat capacity of the system before and after wetting as given by Kirchhoff's equation

$$d(\Delta H)/dT = \Delta C_p$$

$d(\Delta H)/dT$ here is positive It means that the heat capacity of the system after wetting (swollen cellulose-adsorbed water) is more than its heat capacity before wetting, that is, more than the sum of the heat capacity of the dry cellulose and that of the water it can adsorb Such increase in the heat capacity of the system resulting from wetting may be due to some change either in the water, on being taken up by the dry cellulose, or in the cellulose itself, on swelling, or due to a change in both

As to the water, it may be suggested that adsorption causes some depolymerization of the liquid This may take place either directly by the splitting of the adsorbed polymerized molecules on the surface of the cellulose, or indirectly by the selective adsorption of the simple molecules, and thus disturbing the equilibrium between the simple and the polymerized molecules of the liquid Depolymerization of liquid water seems to cause an increase in its specific heat, as suggested by the thermal measurements by Koch[2] These show that the specific heat $C_p$ of the liquid decreases with the increase of pressure at constant temperature At the same time, it is reasonable to think that the increase of pressure would cause an increase in the degree of polymerization Again, Koch's measurements show that $C_p$ increases with the rise of temperature, while this would decrease the degree of polymerization Thus it may be concluded that the adsorbed water has a higher specific heat than that of ordinary liquid water due to a smaller degree of polymerization

As to the cellulose, its swelling is a process analogous to depolymerization, since it represents a partial separation of the cellulose micelles Thus it may be expected that the swollen cellulose would also have a higher specific heat than that of dry cellulose

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## Stability of Complex Salts of Bivalent Metals

IN the study of absorption spectra of inner complex salts of acetylacetone with bivalent metals, we have found the absorption maximum shifts towards longer wave-lengths in the following order

| | | |
|---|---|---|
| Acetylacetone | 273 mμ | alcoholic solution |
| $\text{Zn(acetylacetone)}_2$ | 280 ,, | |
| $\text{Co(acetylacetone)}_2$ | 282 ,, | |
| $\text{Ni(acetylacetone)}_2$ | 294 ,, | |
| $\text{Cu(acetylacetone)}_2$ | 296 ,, | |

The above absorption bands of complex salts are due to the acetylacetone molecules co-ordinated to the central metal, and the displacement of the position indicates the degree of deformation or polarization of ligand molecules In other words, the copper complex salt, which shows the largest displacement, combines with acetylacetone most firmly and is most stable The chemical properties, such as stability against alkali, thermal decomposition, exchange of central metal with other metals in the aqueous solution, etc , also show the remarkable stability of the copper complex salt The manganous and ferrous complexes are very unstable and easily oxidized to the trivalent state Arranged in order of stability, the series is, therefore,

$$\mathrm{Cu} > \mathrm{Ni} > \mathrm{Co} > \mathrm{Zn} > \mathrm{Fe}, \mathrm{Mn}$$

Recently, several studies on the stability of complex salts of bivalent metals with salicylaldehyde[1,2], sodium salicylaldehyde sulphonate[3], *o*-formylnaphthoxide[3] and β,β′,β″-triaminotriethylamine[4] have been published These studies gave the nearly identical stability series of bivalent metals, namely,

$$\mathrm{Zn} < \mathrm{Cu} > \mathrm{Ni} > \mathrm{Co} > \mathrm{Fe} > \mathrm{Mn}$$

Our results are also in accord with these results, and add another example to the stability series of bivalent metals

A part of these results were published in Japanese (*J Chem Soc Japan*, 69, 70 (1948))

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## Analysis of DDT Derivatives by Reversed-Phase Paper Partition Chromatography

FOR the purpose of studying the metabolism in insects of a radioactive bromine analogue of DDT $(Br^*C_6H_4)_2$ CH $CCl_3$ (I), a method was required for the separation and estimation of (I) and the possible metabolites, $(Br^*C_6H_4)_2$ C  $CCl_2$ (II), and $(Br^*C_6H_4)_2$ CH COOH (III), on the micro mole scale It was important that the method itself should not bring about any decomposition of unchanged (I)

We have analysed mixtures of these compounds labelled by bromine-82 by reversed phase[1] unidimensional paper partition chromatography as follows 100 × 2 5-cm strips of Whatman No 1 filter paper were drawn once through a bath of ether containing 2 5 per cent by weight of 'Vaseline', drained, and dried The mixture for analysis (for example, in benzene), which contained not more than 50 μgm of each component, was applied to the top of the strip When the volume of solution was unavoidably large it was applied drop by drop, each drop being allowed to evaporate before applying the next one, so that the 'Vaseline' was not washed away from the zone of application The mobile phase consisted by volume of 80 per cent ethanol, 15 per cent water and 5 per cent '880'-ammonia and was allowed to descend the strip in the usual way

Under these conditions, (I), (II) and (III) moved with $R_F$ values of 0 44, 0 35 and 0 75 respectively In some instances there was an unexplained slight but similar shift in all the $R_F$ values When dealing with unknown mixtures, therefore, a known weight of (I) or (II) was sometimes added as a 'marker' The separated components were located radiometrically by cutting the strips into equal sections and mounting them below a thin end-window Geiger–Muller counter Provided the sections are small and suitably mounted, it may be reasonably assumed that the geometrical distribution of the compound will be the same for each section The weight of compound in each section is negligibly small compared with the weight of the material of the section itself, so that self-absorption of the β-radiation assayed depends only upon the density of the strip and is constant for each section

On this basis the total weight $w$ of a particular component is proportional to the sum of the net rates of count (corrected for decay, dead-time losses, etc ) of the sections associated with a particular peak, that is, $w = k\Sigma a$, where $a$ is the corrected net rate of count for each relevant section, $k$ depends upon the specific activity of the original component and upon the overall counting efficiency It has been found convenient in practice to determine $k$ by surveying a chromatogram run with a known weight of compound of known specific activity In the case of a 100-μgm mixture of (I) and (II), the separated peaks of which run closely, it was estimated that less than 5 per cent of the mixture remained unresolved in 22 hr No isotope exchange between different compounds could be detected when a mixture containing radioactive (I) and inactive (II) and (III) was resolved by this method

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[1] Partridge, S M , and Swain, T , *Nature*, **166**, 272 (1950)

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## A Method for Large-scale Separation of Amino-acids on Filter Paper

FOR quantitative determinations of amino acids separated on filter paper, it is often desirable that the spots should contain a larger quantity of substance than is as a rule possible to achieve with unaffected resolution A one-dimensional technique in which the substance to be analysed is applied along a line across the paper has been described by Yanofsky, Wasserman and Bonner[1] I have successfully applied the following two-dimensional technique for separating comparatively large quantities of amino-acids in bacterial hydrolysates

About 5 mgm or more by dry weight of the hydrolysate was applied as twenty spots along a line 12 cm from the short side of a Whatman No 4 filter paper (46 114 cm ) To make the size of the original spots less than 5 mm in diameter, a condition essential for good separation, the application of the amino-acid solution was effected by means of an 'Agla' micrometer syringe This was operated by a synchronous electric motor to yield 0 01 ml in 12 min To facilitate evaporation, a stream of air was passed over the site of application at the same time as it was slightly heated When all the twenty spots had been applied, the short side of the paper nearer to them was immersed in a glass trough holding a mixture of butanol – water – glacial acetic acid (5 + 5 + 1 parts) and the paper was left hanging in a chromatographic box at 5° C for 85 hr The low temperature was chosen to reduce esterification After 85 hr , the front had run off the paper into a roll of filter paper stapled to the bottom of the sheet as described by Miettinen and Virtanen[2] After drying at 40° C , the paper was cut parallel to its short side into sheets carrying suitable groups of amino-acids The position of the cuts was determined by comparison with standard amino-acids that had run parallel to the unknown substance, then cut off from the main sheet and developed with ninhydrin

To concentrate the amino-acids, now localized as bands across the sheets, they were eluted with distilled water travelling downwards over the papers at right angles to the direction in which the butanol front had been run Care was taken to ensure that the front did not pass a horizontal line 4 cm above the end of the sheet To facilitate accurate control of this position, a couple of stainless steel electrodes were mounted at this level They were connected up in a circuit for measuring the resistance, and when the front changed the conductivity of the paper the trough was emptied by means of an electrically controlled tap and a signal was given The paper was dried at 40° C and the elution process repeated The amino-acids were now accumulated along the line where the front had been stopped The sheets carrying tyrosine, valine, methionine and phenylalanine, *iso*leucine, and leucine respectively were then run against the direction of the elution with *tert* -amyl alcohol in diethylamine vapour according to the method recommended by Work[3] The sheet carrying the rest of the amino-acids was run in the same direction with phenol in an ammonia atmosphere after the topmost part of the paper had been sprayed with phenol to give the front a start over the fastest-running amino-acids

The technique described yields quantities of the different amino-acids which can for example, easily be determined as soluble copper complexes by the method described by Woiwod[4]

C -G Hedén

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Stockholm July 14

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[1] Yanofsky, C , Wasserman, E , and Bonner, D M , *Science*, **111**, 61 (1950)

[2] Miettinen, J K , and Virtanen, A I , *Acta Chem Scand* , **3**, 459 (1949)

[3] Work, E , *Biochimica et Biophysica Acta*, **3**, 400 (1949)

[4] Woiwod, A J , *Biochem J* , **45**, 412 (1949)

## Quantitative Paper Chromatography of Amino-acids

Independent observations made in this Laboratory, during recent months, serve to confirm and to extend the findings recently reported by Fowden and Penney[1], concerning the factors causing loss in the quantitative estimation of amino-acids by paper chromatography Since our experiments have been carried out under somewhat different conditions from those of these authors, and further, since we are not in complete agreement on all points, we feel it is desirable to record our findings

The chief differences in our experimental conditions are the use of (1) Whatman No 54 filter paper instead of Whatman No 4 , (2) phenol/water (4 1), that is, unsaturated, and with the absence of ammonia , (3) lutidine/water (3 1) as a second experimental solvent , (4) an initial temperature of 95–100° for drying chromatograms, the heating current being switched off from the commencement of drying

*Effect of using washed filter paper upon amino-acid recovery* In agreement with Fowden and Penney, we have found that the blanks on untreated filter paper are high and variable, and that treatment of the paper with dilute alkali reduces the blanks very considerably However, we have not found a simple alkali-washing to be sufficient to give consistent blanks and good recoveries The use of a more thorough treatment gives a paper with improved properties, as is indicated in Table 1

Table 1

| Amino-acid chromatographed | Quantity applied (μgm ) | Recovery on paper (per cent) | |
|---|---|---|---|
| | | Washed with alkali | Boiled with alkali |
| Glycine | 10 | 74, 86 | 96, 96, 97 5 |
| Leucine | 10 | 73, 63 | 84, 84, 100 |

The specially treated paper was boiled with four successive portions of 1 per cent alkali and then with water until free from alkali The necessity for such treatment would seem to indicate the presence in the paper of ninhydrin-reacting materials other than ammonia[2]

*Effect of heat in the absence of solvent on the recovery of amino-acids from filter paper* In the range of temperature investigated by Fowden and Penney, heat has practically no effect on the recovery of amino-acids Our work has shown, however, that at higher temperatures (150°) considerable losses occur

Table 2

| Amino-acid | Quantity applied (μgm ) | Average recovery (in μgm ) on drying for 15 min at | | |
|---|---|---|---|---|
| | | 50° | 100° | 150° |
| Alanine | 10 | 10 7 (9)* | 10 1 (8) | 7 5 (8) |
| Glycine | 10 | 9 7 (14) | 9 6 (14) | 7 2 (11) |
| Leucine | 15 | 14 8 (5) | 14 9 (6) | 12 2 (6) |

* Figures in brackets indicate the number of determinations averaged

*Effect of heat in the presence of solvent on amino-acid recovery* Filter paper was spotted with alanine, glycine and leucine, treated with aqueous phenol and dried for 15 min At 150° C losses were considerable ; at 100° they were still appreciable, except in the case of glycine , while at 50° the recovery was satisfactory

Table 3

| Amino-acid | Quantity applied (μgm ) | Average recovery (in μgm ) at | | |
|---|---|---|---|---|
| | | 50° | 100° | 150° |
| Alanine | 10 | 10 7 (2)* | 8 5 (5) | 4 5 (3) |
| Glycine | 10 | 10 2 (4) | 9 5 (6) | 6 6 (4) |
| Leucine | 15 | 14 5 (6) | 12 1 (9) | 6 3 (3) |

* Figures in brackets indicate the number of determinations averaged

*Recoveries of amino-acids from one-dimensional chromatograms* These are shown in Table 4

Table 4

| Amino-acid chromatographed | Quantity applied (μgm ) | Solvent | Recovery in (μgm ) |
|---|---|---|---|
| Alanine | 10 | phenol | 9 3, 9 9 |
| Alanine | 10 | lutidine | 8 5, 9 8 |
| Glycine | 10 | phenol | 8 7, 9 6, 10 2, 9 6, 9 6, 9 75 |
| Glycine | 10 | lutidine | 9 6, 10 7, 10 9 |
| Leucine | 15 | phenol | 14 4, 14 7, 12 7, 12 6, 12 6, 15 |

It is to be noted that the results do not indicate that the behaviour of glycine differs notably from that of other amino-acids

In all cases amino-acid contents of papers were determined by the method of Moore and Stein

The above data are recorded with the permission of the South African Council for Scientific and Industrial Research

L Novellie

National Chemical Research Laboratory,
S A Council for Scientific and Industrial Research,
Pretoria July 18

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[1] Fowden, L , and Penney, J R , *Nature*, **165**, 846 (1950)

[2] Wynn, V , *Nature*, **164**, 445 (1949)

## History of Chromatography

All those interested in the history of chromatography, including the authors of the present communication, have hitherto accepted the claim that M S Tswett was the discoverer of this extremely fruitful method of analysis A detailed survey of the early literature of adsorption in petroleum technology recently initiated by one of us (H W )[1] strongly suggests that, despite the powerful influence which his experiments have undoubtedly had on later generations, Tswett has, in fact, received considerably more credit than is his due

So early as 1897, D T Day[2], pursuing investigations of the methods by which natural petroleum is formed and transformed, showed that if crude petroleum is forced upwards through a column of powdered limestone some fractionation occurs and the oil which first emerges is thinner and lighter in colour than that which follows A similar commercial process had, indeed, been devised some ten years previously for the petroleum industry by C Engler and M Boehm for the bleaching of oil and the proluction of petroleum jelly The oil to be bleached was passed through six batteries of adsorbents each containing about one kilo of charcoal Similar adsorbers were described by other contemporary authors[4,5], but such processes are, of course, essentially what Fink[6] has called adsorptive filtration rather than true chromatography Day, however, carried his experiments further and on August 20, 1900, exhibited in Paris, at the First International Petroleum Congress, hydrocarbon fractions which he had isolated by differential adsorption on a column of fuller's earth The full text of Day's ecture to the Congress[7] is not now available, but abstracts and comments upon it were published by various authors who were present[8–10] Petroleum from the top of the column, in which the crude material rose by capillary action, approximated to a first distillate, from the centre a heavier oil was obtained, and from the bottom a semi-solid petroleum elly From the contemporary accounts it is quite clear that Day was well aware of the possibilities and the importance of his method for the analysis of hydrocarbon mixtures of all kinds At a dinner given on the evening following the lecture, the president, B Dvorkovitz[11], referred to Day's discovery as outstanding, saying that like all great discoveries "it ooks simple—in fact is simple—but it requires much previous thought, patience, and perseverance" Day did not realize his hopes of sufficiently perfecting his method within a few months to isolate pure individual hydrocarbons, though over a period of years he and his co-workers effected many successful fractionations[12–16], and he did not recognize the supreme importance of adsorption in the process until much ater, looking upon it at first as chiefly a capillary effect, such as was then known to occur in the wicks of lamps Nevertheless, it is difficult to regard his method as anything but a crude form of chromatography L Zechmeister's opinion[17] that Day "might in favourable circumstances have been successful in he elaboration of chromatographic procedures" eems, therefore, rather less than just, for Day conorms closely to that author's definition of chromatography as "those processes which allow the resolution of solute mixtures by selective fixation and liberation on a solid surface or support, with the aid of a fluid treaming in a definite direction"

It is not Day alone, however, who may claim to have anticipated Tswett C Engler was present at Day's lecture in Paris, and at once proceeded with E Albrecht to elaborate the method in experiments[8] which seem to have been completely overlooked They accelerated the rate of flow through their olumn by using a large head of liquid They collected, at fixed intervals, successive fractions emerging from he top of the column and distinguished them by determination of such physical properties as density, iscosity and boiling-point In fact, they undoubtedly ormed a liquid chromatogram, a technique normally scribed to Koschara some thirty-five years later They carefully investigated the mechanism of the rocess by using a specially built column containing orts at intervals along its length so that samples ould be withdrawn for analysis They did not restrict hemselves exclusively to hydrocarbon mixtures but tressed the applicability of the method in other elds, and they ascertained the physical nature of he process

Russian petroleum chemists *inter alia* also took p the method Herr[18], for example, fractionated Baku petroleum by percolation through fuller's earth, forming, like Engler, a flowing chromatogram He introduced optical methods for identifying various fractions, and showed that aromatic fractions could chromatographically be separated from aliphatic ones Phyala[19], too, carried out effective chromatographic analyses of Baku petroleum, though, like Day, he was inclined to attribute the separation to capillary forces rather than to adsorption

It now seems clear that by the time Tswett performed his chromatographic isolations of plant pigments there already existed a considerable literature on the subject, in English, French, German and Russian, published in well-known journals by chemists of repute Furthermore, a form of chromatography had been described in detail at the First International Petroleum Congress in Paris and there singled out as a particularly important discovery It is therefore highly probable that Tswett, who had travelled widely and was by no means parochial in his interests, was aware of what had already been done That he made no acknowledgment is not altogether surprising and need not reflect upon him, for, as a botanist, his interest in chemistry was quite clearly limited to using it as a means of attaining his own ends For example, a botanist using a new dye to stain sections would not normally refer to the chemical research involved in the synthesis of the dye Furthermore, his work, as is well known, attracted little attention at the time and there was, therefore, no occasion for him to give any detailed explanation of how he developed his method When interest in chromatography revived about 1930 it was again at first used for the isolation of natural pigments and it was therefore natural for the workers concerned to refer back to the work of Tswett in the identical field rather than to the earlier work in the less familiar field of petroleum technology Nevertheless, it appears that the discovery of chromatography ought properly to be associated with the names of Day and of Engler and Albrecht rather than with that of Tswett, and that this year, therefore, marks the fiftieth anniversary of the discovery Further particulars on the work of Day are being published elsewhere[1]

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[2] Day, D T, *Proc Amer Phil Soc*, **36**, 112 (1897)

[3] Engler, C, and Boehm, M, *Dingler's Polytechnisches J*, **262**, 470 (1868)

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[5] Burgmann, A, "Petroleum and Erdwachs" (Leipzig, 1897)

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[15] Day D T, *Trans Amer Inst Min (Metall) Engrs*, **41**, 219 (1911).

[16] Gilpin, J E, and Schneeberger, P, *Amer Chem J* **44**, 251 (1910)

[17] Zechmeister, L, "Progress in Chromatography, 1938–1947", 30 (London, 1950)

[18] Herr, W E, *Petroleum*, **4**, 1284 (Berlin, 1908–9)

[19] Phyälä, E, *Petroleum*, **5**, 1525 (Berlin, 1910)

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

## Saturday, December 9

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2 30 p m — Prof Granville Poole Inaugural Address

## Monday, December 11

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W C 1), at 5 30 p m —Prof J B S Haldane, F R S "Inverse Probability"

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology Manchester) at 5 30 p m — Prof Sir Robert Robinson, O M , F R S "Chemistry of Penicillin" (Ramsden Memorial Lecture) *

## Tuesday, December 12

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N W 8), at 5 p m —Scientific Papers

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London W 1), at 5 30 p m —Dr Ir Hoog ' The Development of Catalysts in Industrial Chemistry"

ILLUMINATING ENGINEERING SOCIETY (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 6 p m — Dr B P Dudding "The Development of the Tungsten Lamp"

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6 15 p m — Dr C M Blow "The Testing and Grading of Raw Rubber"

INSTITUTION OF WORKS MANAGERS WEST MIDLAND BRANCH (at the Grand Hotel, Birmingham), at 7 p m —Mr T Dean 'Material Handling"

SHEFFIELD METALLURGICAL SOCIETY (at the Grand Hotel, Sheffield) at 7 p m —Mr G M Gemmill "Problems in the Development of Creep Resisting Steels"

## Wednesday, December 13

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College, Prince Consort Road, London, S W 7), at 11 15 a m and 2 10 p m —General Meeting and Scientific Papers on "Some Aspects of Applied Biology Overseas"

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi London, W C 2), at 2 30 p m —Prof A C Menzies ' Modern Trends in Spectroscopy" (Peter Le Neve Foster Lecture)

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 5 p m —Scientific Papers

MANCHESTER STATISTICAL SOCIETY (at the Reform Club, King Street, Manchester), at 5 30 p m —Mr R Silvey "The Methods by which the B B C Endeavours to Measure Viewing"

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B M A House Tavistock Square, London, W C 1), at 5 30 p m —Mr M H Mannering and Miss P Davis ' Mouldlike Growth in certain Bacteria"

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-EASTERN SECTION (at the Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p m —Mr H J Barton Chapple "A Survey of Television Development and its Problems"

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 15 p m —Dr J Sword and Miss A M Copping "Factors in Distribution affecting the Quality and Nutritive Value of Foodstuffs, 2, Cereals"

SOCIETY OF CHEMICAL INDUSTRY, BIRMINGHAM AND MIDLAND SECTION (joint meeting with the FINE CHEMICALS GROUP, in the University Mason Theatre, Edmund Street, Birmingham), at 6 30 p m —Mr A R Lockwood "Dextran Blood Plasma Substitute"

ROYAL STATISTICAL SOCIETY, TEES-SIDE SUB-GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the William Newton School, Norton, Stockton), at 7 15 p m —Mr G P Sillitto "The Number of Observations required in Experiments"

## Thursday, December 14

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department Imperial College of Science and Technology, Imperial Institute Road, London, S W 7), at 2 30 p m —Scientific Papers

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 4 p m —Messrs K W Hillier, H Kolsky, J R S Waring and A J King Papers on ' The Dynamic Properties of Resilient Materials"

ROYAL SOCIETY (at Burlington House Piccadilly, London, W 1), at 4 30 p m —Prof F J Cole, F R S "The History of Microdissection" (Wilkins Lecture)

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 5 p m — Prof A S Besicovitch "Parametric Surfaces"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S W 1), at 6 p m —Dr G S Hislop "The Investigation of Gusts"

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Chemistry Department, The University, Manchester), at 6 30 p m —Scientific Papers

INSTITUTE OF METALS, SHEFFIELD SECTION (at the Grand Hotel, Sheffield), at 6 30 p m —Mr R Haynes "The Isothermal Transformation of Copper-Base Alloys"

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London W 1), at 7 30 p m —Scientific Papers

TEXTILE INSTITUTE, KIDDERMINSTER AND DISTRICT SECTION (in the Staff Canteen, Carpet Trades, Ltd , Kidderminster) at 7 30 p m — Mr R H K Thomson "Ardil"

## Friday, December 15

BIOCHEMICAL SOCIETY (in the Department of Biochemistry and Chemistry, Medical College of St Bartholomew's Hospital, Charterhouse Square, London, E C 1), at 2 p m —Scientific Papers

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S W 7), at 5 p m —Wing Comdr H P Ruffell Smith "Psychological Aspects of Instrument Presentation"

ASLIB (at the Department of Scientific and Industrial Research Charles House (Room 411), 5–11 Regent Street, London, S W 1) at 5 30 p m —Mr F C Francis Report of the Unesco Conference on the Improvement of Bibliographical Services held in Paris 7th–10th November 1950

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6 15 p m —Prof Ir L Troost 'Open Water Test Series with Modern Propellor Forms , Part 3, Two-bladed and Five-bladed Propellors – Extension of the Three- and Four-bladed Series"

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 3 Welbeck Street, London, W 1), at 6 30 p m —Mr Day ' Radiation Chemistry with Emphasis on Dosimetry"

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 7 p m — Colonel C T Wells "Training for Management"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 9 p m —Sir Harold Spencer Jones, F R S "The Origin of the Comets"

## Saturday, December 16

BRITISH PSYCHOLOGICAL SOCIETY (in the Anatomy Theatre, University College, Gower Street, London, W C 1), at 2 30 p m —Dr F M Earle "Prognostic Value of Ability Tests at 10, 11, 12—a Four-Yea Follow up"

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

SENIOR SCIENTIFIC OFFICER with a degree in engineering (preferably Civil), for the Long Range Weapons Establishment, South Australia—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S W 1 (December 14)

SUPERINTENDING SCIENTIST (with honours degree in physics or electrical engineering) at the Electronics Laboratory of the Department of Supply, Adelaide—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S W 1 (December 14)

LECTURER and a TEMPORARY LECTURER IN THE DEPARTMENT OF BACTERIOLOGY of the Senior Medical School, Dundee—The Secretary The University, St Andrews (December 15)

ASSISTANT (with a degree in agriculture or equivalent qualifications, TO THE HEAD OF THE BIOLOGICAL AND AGRICULTURAL SECTION of the Technical and Scientific Register—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House Kingsway, London, W C 2, quoting G 296/50A (December 16)

ENGINEERS (Scientific and Experimental Officer grades) at the Royal Aircraft Establishment, Farnborough, particularly for experimental and design work on light mechanical engineering problems including servos, and for work in the field of aeronautics and ballistics (*a*) SCIENTIFIC OFFICERS (Ref C 382/50A) with a good honours degree in appropriate subject, or equivalent qualification, (*b*) EXPERIMENTAL OFFICERS (Ref C 383/50A) with Higher National Certificate in mechanical or light electrical engineering, or equivalent or higher qualification—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2 quoting the appropriate Ref No (December 16)

BIOCHEMIST (with a degree in biochemistry or physiology) in the Veterinary Research Division of the Ministry of Agriculture, Stormont Belfast—The Secretary, Civil Service Commission, Stormont, Belfast (December 19)

ASSISTANT TEACHER (with a degree or equivalent qualification in chemistry) to teach Inorganic Chemistry to Higher National Certificate standard at the Widnes Municipal Technical College—Mr W R Wainwright, Education Office, Lugsdale Road, Widnes, Lancs

ASSISTANTSHIP IN RESEARCH (the holder of the post will be expected to devote his time to the application of electronic technique to spectroscopy, especially in the infra-red, and to related physicochemical problems)—Dr N Sheppard, Department of Colloid Science The University, Cambridge

CHEMISTS (Experimental Officer grade) in Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2 quoting F 704/50A

PRINCIPAL-DESIGNATE OF THE NEW INSTITUTE OF HORTICULTURE which will be established near Pershore—The Director of Education Castle Street, Worcester

PROFESSOR OF AGRICULTURE (Soil Science) in the School of Agriculture, Canterbury Agricultural College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, Gordon Square, London, W C 1

REGIONAL TRIALS OFFICER (with a university degree or diplom in agriculture and/or biology)—The Secretary, National Institut of Agricultural Botany, Huntingdon Road, Cambridge

RESEARCH ASSISTANT (young woman recently graduated in biological sciences)—The Sir William Dunn School of Pathology, Sout Parks Road, Oxford

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# CHEMICAL ENGINEERING IN GREAT BRITAIN

IT was an Englishman, G E Davis, who, by his lectures in Manchester in 1887 and his world-famous book "A Handbook of Chemical Engineering" published in 1901, may well be regarded as the father of chemical engineering British chemists and engineers refused to accept what they considered to be a hybrid profession, and the result was the appalling scarcity, revealed by the First World War, of men capable of designing and operating chemical plant for the manufacture of drugs, dyestuffs, explosives, etc After that War, progress was slow, and training in Great Britain was haphazard for many years , full appreciation of the value of the chemical engineer was left to the United States, where the profession made great progress

An official expression of interest in chemical engineers in Great Britain in the form of a short but exceedingly informative report issued by the Ministry of Labour and National Service* is therefore very welcome It has been prepared by a sub-committee of the Technical Personnel Committee under the chairmanship of Prof A M Tyndall, and it sets out with great clarity the position of chemical engineers in Great Britain under the headings "The Training of Chemical Engineers", "Fields of Employment", "Estimates of Supply and Demand", and "Widening Possibilities of Employment"

The sub-committee explains at the outset that it has been faced with an unusual difficulty in forming estimates of the future demand for chemical engineers , this is summed up in the words "An appreciation that chemical engineering is a distinct technology has been and is growing but slowly in this country" How like the opening words of Davis's book written fifty years ago "The functions of the chemical engineer are very generally misunderstood" There are still influential employers who either state definitely that they do not require chemical engineers, or hold the peculiar view that a chemical engineer is best produced by training him in some other branch of technology A major problem before the sub-committee was consequently to estimate not only the obvious requirements for chemical engineers, but also the extent to which these die-hard employers might become converted, and for this reason it has not ventured on any predictions further ahead than five years

The report details the ways which are open to a chemical engineer to secure professional status, and views with approval the fact that the different systems of training produce men with varying outlooks One fact, to which the sub-committee does not direct attention, is that the first chemical engineering degree courses in Great Britain were started at two London colleges only in 1939, and owing to the Second World War have had insufficient time to develop in the manner intended Because of the small number of students and shortage of staff, it was found necessary for the former to attend existing courses in chemical and engineering subjects This procedure has also been adopted in other institutions, with not altogether satisfactory results , those who devised the course unanimously agreed that, chemical engineering being based on the fundamental principles of mathematics, physics and chemistry, these principles should first be explained, and students should then be shown how to apply them to the solution of practical problems and the design of new processes and plant The subjects of the course must be carefully selected so as to show their interrelation, and teaching should be conducted by chemical engineers

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* Ministry of Labour and National Service Technical and Scientific Register Present and Future Supply and Demand for Persons with Professional Qualifications in Chemical Engineering Pp 24 (London H M Stationery Office, 1950 ) 6*d* net

The report gives illuminating figures for the numbers of chemical engineers employed by the main groups of industries As might be expected, the chemical industry heads the list with 864 in 1949, a figure which is expected to grow to 1,463 by 1954, although in 1938 it was only 286 Chemical plant manufacture is the second largest group The average annual rate of expansion for the period 1938–49 for all industries was 10 per cent, and the same figure is expected in the period 1949–54

This rapid development will require, in all, 1,310 new qualified chemical engineers during the five years, allowing for wastage Against this, the estimated supply is 1,096, and this figure includes 240 men taking the Institution of Chemical Engineers examination Many of these men are already employed as chemical engineers although not qualified, and in some cases others will be required to take their places. The great shortage disclosed by these figures is by no means the whole story , the deficit of about two hundred must be regarded as a minimum for two main reasons First, the estimated number of those taking degrees probably represents in most cases the maximum that can be given instruction with existing accommodation and proposed extensions it is by no means certain that the output will actually reach these figures Secondly, it is quite clear that the number of new openings for chemical engineers is bound to increase rapidly in the near future, a point frequently emphasized in the report

The sub-committee briefly discusses how the shortage could best be met, whether by founding new schools or by expanding those which already exist, and strongly favours the latter method With this view, most chemical engineers engaged in teaching will agree , but the practical difficulties may not be fully appreciated The success achieved by chemical engineers in the past is undoubtedly due largely to a rigorous selection before entry to the university and even more to the small size of the classes, which has made possible a close personal contact between the teacher and his students , about twenty would seem to be the largest number suitable for tuition of this kind A similar number is roughly the maximum for practical work in the drawing office and laboratory and for visits to works Any expansion to conform with this requirement cannot be gradual but must be by quanta, each quantum being a group of about twenty students working separately, except perhaps for formal lectures, and requiring a separate staff This introduces a question not raised by the sub committee as to who is to do the training The repor mentions a requirement of thirty lecturers to b recruited during the next five years, a figure whic must seem to many to be on the low side But ho are even thirty to be obtained ? The best men ca command interesting and responsible posts in industr with high salaries, within a few years of leavin college , scarcely any consider the possibility of a academic career A peculiar position thus arises i which the attractiveness of the profession seem likely to contribute to its extinction Although th report of the sub-committee is most welcome to a chemical engineers, it is clear that the key to th fulfilment of its forecasts lies in the provision o incentives to attract a sufficient number of chemica engineers to the profession of teaching in the universities and other institutions of university standing i Great Britain

# PLANT PHYSIOLOGY AFTER SACHS

Fifty Years of Plant Physiology
By Prof Th Weevers Pp xi+308 (Amsterdam Scheltema and Holkema, 1949 ) n p

THE fifty years referred to in the title are thos from 1895 to 1945 and they correspond ver closely with the working life of the author Prof Weevers tells us in his introduction that it was in th former year that he entered the University o Amsterdam as a student under de Vries The earlie date has also further significance Sachs, who mor than anyone else had been responsible for laying th foundations of modern plant physiology, died i 1897 and a phase in the development of the subjec ended Again, the "History of Botany" written b Sachs, which covered the period up to 1860, wa continued by Reynolds Green to cover the next fort years, so that the year 1895 or thereabouts is convenient time from which to continue that histo further to the present time Dr F W Went, in a introduction to Prof Weevers's book, suggests tha this is Prof Weevers's intention However, the boo is scarcely a history in the ordinary sense, though i might be regarded, as Dr Went says, as a "Text book of Plant Physiology on a Historical Basis" I scarcely emphasizes general trends of developmen sufficiently to be regarded as a history

We are also told by Dr Went that much stress i laid, deliberately, on contributions from the Netherlands This is, of course, very understandable, and Prof Weevers has every reason to be proud of th contributions made by his fellow countrymen, for w have come to regard the plant physiological labo atories of Holland as centres of research of the highest quality It does, however, appear to have led to a certain lack of balance in the treatment of the subject Thus quite a lot of space is rightly devoted to respiration , but Blackman's theory of oxidative anabolism is dealt with in a few lines and the implications of the theory scarcely indicated Blackman's interpretation of his experimental findings may o may not have been correct , but there can be little question of the importance of the theory as a stimulant to further work Again, in dealing with photosynthesis, the work of the Cambridge school under Blackman's direction receives rather brief mention, and some of it is not discussed at all, yet this was probably the most solid contribution to our knowledge of photosynthesis of the years under review. There is also no mention of the work of R. Hill on oxygen evolution by isolated chloroplasts, work which is now generally regarded as of considerable importance in the analysis of the photosynthetic mechanism. Another notable omission is found in the lack of any reference to the work of Gregory and Purvis on vernalization and photoperiodism, yet this is some of the most significant work which has been done in this field. One might also have expected some account of the long series of researches on seed dormancy and germination carried out under Crocker's direction at the Boyce Thomson Institute.

However, no one could deal adequately, in the space of some three hundred pages, with even the more important researches in plant physiology of the period under review, and we can readily forgive the omissions in Prof. Weevers's book in view of the very considerable amount of information which it contains. The various aspects of plant physiology are dealt with under eleven headings, of which, on the metabolic side, most space is devoted to respiration and mineral nutrition, the latter rather curiously including photosynthesis and nitrogen assimilation. Other chapters deal with imbibition and diffusion, water movement, translocation and the metabolism of heterotrophic plants. The last five chapters of the book deal with various aspects of growth and irritability, and here, in particular, the British reader is likely to find much information which is new to him.

"Fifty Years of Plant Physiology" should certainly be read with interest by all students of botany, and the reviewer will not be alone in feeling particularly grateful to Prof. Weevers for publishing his book in English.

W. STILES

# PHARMACOLOGY AND TOXICOLOGY OF URANIUM COMPOUNDS

Pharmacology and Toxicology of Uranium Compounds

With a Section on the Pharmacology and Toxicology of Fluorine and Hydrogen Fluoride. Edited by Dr. Carl Voegtlin and Prof. Harold C. Hodge. (National Nuclear Energy Series, Manhattan Project Technical Section, Division 6, Vol. 1.) Part 1. Pp. xviii+524. Part 2. Pp. iv+525–1084. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 2 Parts, 60s.

THIS volume is the result of several years of experimental investigation and study carried out by the Division of Pharmacology of the Manhattan Department of the University of Rochester. The prefaces and forewords themselves will be found useful to the uninitiated in the understanding of such mysterious terms as Manhattan Project, etc. The historical foreword is a mine of information in itself and should serve as a lucid example of the manner in which toxicological investigations should be planned, while the introduction of thirty-seven pages is, in fact, an excellent and valuable summary of the whole. The major portion of the first volume deals with the pharmacology and toxicology of uranium and its compounds, while the remainder is a useful review of the pharmacology and toxicology of fluorine and hydrogen fluoride.

The initial aim of these investigations was to determine the potential hazards to man of the use of uranium on a scale hitherto unknown, and it is most striking throughout that, although experimental animals were under investigation, at no time has this aim been lost sight of. Throughout the whole work, the implications of experimental findings are clearly and concisely discussed in regard to their importance to man.

The chemistry of numerous uranium compounds is considered, especially with regard to their mechanism *in vivo* and the importance of such vital phenomena as the formation of anionic complexes. Analytical methods are lucidly outlined, and the necessity for the application of statistical procedures to results discussed. A brief, but extremely useful, review of statistical methods and their meaning is included and should be read by anyone who desires to understand the results of experimental investigations fully and yet has not the necessary background of statistics to do so. The chapters dealing with the histopathology and mechanism of uranium poisoning stress the fact that uranium is essentially a nephrotoxin, and that the urinary excretion of catalase, phosphatase and protein are the only reliable indexes of poisoning.

Toxicity studies were made following the administration of uranium compounds by various routes, and the overwhelming importance of the inhalational route is stressed, since lung absorption exceeds by many times the absorption from any other location. The relative toxicity of various uranium compounds when administered by inhalation is outlined in a most useful table (Fig. 2, p. 40), where it is shown that uranium hexafluoride is probably the most toxic and pitchblende the least toxic compound.

The relationship between particle size, lung retention and solubility of uranium dusts is logically discussed with reference to toxicity, and the importance of these factors, when applied to human exposure, is considered at some length. With regard to the question of solubility, it is emphasized that the solubility of a given dust in water is not necessarily the same as that in tissue fluids; for example, uranium peroxide, although very insoluble in water, was discovered to be fairly soluble in serum and, therefore, proved to be a highly toxic dust.

The metabolism of uranium within the living organism has been given due consideration, and the influence of valence state upon the pattern of storage and excretion discussed, especially with regard to the parts played by bone and kidney. One of the significantly important aspects of uranium toxicology was discovered to be the development of resistance to some of the toxic phenomena, and this problem is discussed at some length. Consideration is also given to the biological action of uranium on enzymes and proteins, first, with regard to specific effects upon the kidney tubules, and, secondly, with regard to the mechanism of uranium transport in the blood. Catalasuria is considered in some detail, since it was found to be the most valuable and sensitive test for the early detection of kidney tubule damage by uranium. The relative merits of numerous other kidney function tests in this respect are also outlined throughout the volume. Chapter 15 attempts to place the whole mass of experimental evidence in its correct perspective with regard to the primary mode of action of uranium compounds on the animal body, and succeeds extremely well in this respect.

The final chapter of Part 1 deals with the problem of human exposure, and discusses in this respect the clinical findings and observation made following a few accidental acute exposures, mainly to uranium hexafluoride. The effects of chronic uranium exposure are also considered with reference to workers in the uranium industry—150 μgm. of uranium per cu. m. of air being the maximum permissible level of air contamination set for industry at the time, and not 50 μgm. as at present applicable in Great Britain. Finally, an outline is given of the extensive studies carried out on individuals employed in various uranium-processing plants. Many may consider the scope of these investigations to be unnecessarily complex.

Part 2 of this work is devoted to a consideration of elemental fluorine and hydrogen fluoride. Inhalational toxicity is considered, and the methods of treatment of the two major types of burns (thermal and chemical) outlined. It was discovered that fluorine produces a burn that is predominantly thermal in character as compared with the peculiar chemical nature of the hydrogen fluoride burn.

The appendix contains details of the large complex organization that went to make up the Manhattan Department of the University of Rochester. An excellent index is included. Any imperfections in manner of presentation, which certainly could be improved upon, can be excused (as mentioned in the volume editor's preface, p. xiii) by reason of the fact that the manuscript was completed to a time schedule by the limited number of personnel remaining after many of the original investigators had returned to other work. ALAN BUTTERWORTH

# THE DIVINING ROD

## Psychical Physics

A Scientific Analysis of Dowsing, Radiesthesia and kindred Divining Phenomena. By Prof. S. W. Tromp. Pp. xv+534. (Amsterdam and New York: Elsevier Publishing Co., Ltd.; London: Cleaver-Hume Press, Ltd., 1949.) 60s.

THERE are three schools of thought about dowsing: that it is a physical process; that it is a branch of parapsychology (psychical research), diagnosis being made by a process akin to telepathy; and thirdly that it is charlatanry. S. W. Tromp, of Leyden, now professor of geology in the University of Cairo, believes "that these phenomena can be explained by the normal physical and physiological laws". Nevertheless, he calls his 534-page book "Psychical Physics". Chapter 1 deals with electromagnetic and electrostatic fields in living organisms (ranging from Donnan equilibria and brain-rhythms to Gurwitsch's "mitogenetic rays"), in the earth's crust (orthodox geophysics) and in the atmosphere (meteorology). Chapter 2 deals with the influence of electromagnetic and electrostatic fields on living organisms, including reports of their effects on growth of plants and animals, on cancer, and in pain relief. Chapter 3 is mainly concerned with dowsing for water, metals and magnetic fields, with sexing and with diagnosis of disease by pendulum and the like, the emphasis being on magnetic fields and the author's own experiments. Tromp makes no attempt to distinguish sound from unsound work, though he presents a balanced case for Gurwitsch.

Can dowsers substantiate their claims? Tromp by-passes this fundamental question. Recent reviews (by parapsychologists) of literature on dowsing maintain that the verdict cannot be given until more rigid tests have been carried out. In New South Wales the practice of dowsing is widespread; the Water Conservation and Irrigation Commission's records, kept since 1918, show that 84 per cent of bores were successful on undivined sites against 70 per cent on divined sites. I have often asked dowsers "Do you find a knowledge of geology a useful adjunct?" The answer has always been quite frank: "Very useful indeed"; but the problem of testing the dowsing claim in the field becomes acute. Laboratory tests usually fail, and few dowsers now claim to succeed under laboratory conditions.

In the assessment of their claims, dowsers have had to put up with a good deal of prejudice by men of science. Tromp's book and, in particular, his own experiments will do little to dissipate it. He claims, for example, to have proved that dowsers can detect changes in field-strength of 0.001 oersted. He quotes ten single trials in which a blindfolded student indicated whether he got a reaction while standing near a tangent galvanometer when the ring was either moved from a horizontal to a vertical plane (and vice versa) or not moved at all. The subject scored nine out of ten. Reference to the original paper (*Tijdschrift voor Parapsychologie*, 15, 39; 1947) reveals that Tromp's claim in this book is based on these ten trials alone. Moreover, the 'targets' were not presented in a random order—an elementary rule in all parapsychological 'guessing' experiments.

In the old days the dowser just dowsed, and either found water or did not. Things are more complicated to-day. Tromp needs twenty pages (pp. 340–60) to describe the factors liable to influence or disturb the dowser—conductivity of the soil, human skin potentials, sunlight, cosmic rays, gases and dust in the air, vegetation, atmospheric potential gradient, and numerous others. Since valid evidence for the primary phenomenon is hard to come by, it is pertinent to ask how small differential effects can have been established with certainty.

The book has a valuable list of references. The *Proceedings of the Society for Psychical Research* are confused with the *Proceedings of the National Laboratory of Psychical Research*, and there are many misprints throughout the book. DENYS PARSONS

# PATENTS AND INDUSTRIAL DESIGNS

## Patents for Inventions and the Registration of Industrial Designs

By T. A. Blanco White. Pp. lix+389. (London: Stevens and Sons, Ltd., 1950.) 45s. net.

## Patents and Registered Designs and their Exploitation

By T. A. Blanco White. (This is the Law Series.) Second edition. Pp. ix+79. (London: Stevens and Sons, Ltd., 1950.) 4s. net.

IN the first and the larger of these two books, which is the one with which we are here chiefly concerned, Mr. T. A. Blanco White is to be congratulated upon producing such a useful work written around the Patents Act 1949 and the Registered Designs Act 1949, both of which came into force at the beginning of this year A text-book upon the law of patents and industrial designs is necessarily addressed to more than one class of reader Although the bulk of the book is addressed to practitioners, it includes useful material for the novice, and those parts of the text which assume familiarity with the subject as a whole have been conveniently printed in smaller type However, the novice would perhaps do best to begin with the second book, "Patents and Registered Designs", which is the author's smaller and more popular work and which first appeared in the series of books entitled "This is the Law" It has been rewritten in the light of the amendments arising from the new Acts

The author has displayed in his larger work not only fine qualities of scholarship, but also a sense of the humanities rarely displayed in text-books of this kind The spirit in which it is written may reflect in some way the spirit in which the committee, set up in 1944 by the President of the Board of Trade under the chairmanship of Sir Kenneth Swan, tackled the formidable task of reviewing the law and procedure of patents and industrial designs in the light of present-day technical developments and industrial requirements This committee, which presented three reports (First Interim Report, 1945 (Cmd No 6618), Second Interim Report, 1946 (Cmd No 6789), and the Final Report, 1947 (Cmd No. 7206)), recommended a large number of amendments to the existing law, but did not recommend any radical change in the fundamental principles of the British patent system

When the New Patents and Designs Bill was presented to Parliament, approval was given to the unanimous view of the Swan committee "in favour of the retention of the present (patent) system in this country and this view is supported by witnesses who have appeared before us, representing both inventors and the commercial users of inventions" It is interesting to record that the National Patent Planning Committee of America reported a similar conclusion in 1943 in respect of the American patent system But if the theory behind the patent system was right, the procedure for carrying it into practical effect needed a drastic overhaul The new Patents and Designs Acts, while consolidating and codifying the existing law, incorporate substantially all of the amendments proposed by the Swan committee Practically the whole of the existing provisions of the earlier Acts have been rewritten, and decisions of the courts upon the meaning of the wording of earlier Acts have been incorporated No such recasting of the form of the law of patents has occurred since the sweeping changes made by the Patents Act of 1883 It is hoped that the main intended benefits of the new Acts to encourage technical development and to cheapen litigation will be effected in practice With these ends in view, a special judge, the Hon Mr Justice G Lloyd-Jacob, has already been appointed to deal with patent and designs matters in the Chancery Division of the High Court and in the Patents Appeal Tribunal These many changes in the law have made the task of the author very difficult, but he has wisely adopted the course of reducing to a minimum any reference to the older law or to authorities turning on the wording of earlier statutes Helpful comparisons of the old and the new Acts together with notes have been included in the tables of the Statutes

The book commences with an admirable essay upon the British patent system Eleven further chapters provide a concise exposition of the complicated law of patents and designs the structure and interpretation of patent specifications, infringement and validity of patents, the practice of the Patent Office, the scope of the activities of which has been increased by the Acts, assignment and devolution of patents and designs, including the new provisions regarding the rights of an employer to inventions made by an employee, registration of industrial designs, licensing of patents and designs, including provisions for preventing abuse of monopolies, Government use of inventions and designs and procedure for obtaining compensation for Crown use The latter section contains a reference to the work of, and the principles laid down by, the Royal Commission on Awards to Inventors which in 1947 commenced hearing claims in respect of use by or on behalf of the Crown of war-time inventions The author, in carefully and objectively setting out the many changes in the law effected by the new Acts, has avoided giving his interpretations of many new wordings of the Act, although he has included many penetrating comments There are no decisions of the court in regard to the new Acts to guide him, but he has endeavoured to place the amendments in perspective in relation to the previous law

Thus, the grounds of opposition to the grant of a patent have been widened so that for the first time there should be a real prospect of obtaining the refusal of patents that have no substantial chance of being valid The problem of inventions which should be kept secret on the ground of national security has received close attention, particularly when the invention may be concerned with atomic energy Wide powers for amending specifications have been given The law of compulsory licensing has been simplified and extended, but how far the new provisions will be of value to industry or only a source of extensive legal actions remains to be seen Some of the provisions are complementary to the provisions of the Monopolies Act, which provides for the breaking up of monopolistic arrangements except in so far as they involve United Kingdom patent rights

There are several important amendments in connexion with infringement of patents Thus, for the first time, an exclusive licensee can sue for infringement as if he were the owner of the patent Again, another most important innovation is that infringement proceedings may, if agreed between the parties, be dealt with by the Patent Office But the Comptroller-General of Patents cannot award more than £1,000 damages unless the parties otherwise agree As the author points out in a footnote, "The use of this sort of procedure will involve a change in the attitude of patentees towards infringement proceedings At present most patentees sue mainly for the injunction (which the Comptroller-General of Patents will be unable to grant) But there must be many small patents that would be well worth while suing upon if the patentee could be certain that his costs would not be large compared with £1,000 It remains to be seen what these proceedings before the Comptroller will in fact cost"

These two new Acts are further milestones in the history of the development of the law relating to industrial property, and Mr Blanco White's two books together should provide very useful guidance to manufacturers and scientific workers as well as legal practitioners

R G Lloyd

### Sir Isaac Newton · Theological Manuscripts

Selected and Edited with an Introduction by Dr H. McLachlan Pp vii+147 (Liverpool University Press of Liverpool, 1950) 7*s* 6*d*

MEMBERS of the general public have not been accustomed to associate Newton with theological controversy, though considerable interest was aroused by a lecture—"Newton, the Man"—prepared by the late Lord Keynes and read by his brother, Mr Geoffrey Keynes, at the Newton Tercentenary Celebrations held by the Royal Society in 1946 In this lecture attention was directed to the Newton Papers which had been in the custody of Viscount Lymington and which in 1936 were offered for sale Through the generosity of Lord Keynes, many of these papers ultimately found their way to King's College, Cambridge, ten of the theological manuscripts have been selected and edited by Dr H McLachlan in the volume under review

The value of the book is enhanced by the author's introduction In the first part are indicated the scope and subsequent history of Newton's writings on religion These were numerous, according to Prof Andrade's estimate, "there were over 1,300,000 words in MSS on theology in the Portsmouth Collection" In the second part of the introduction Dr McLachlan traces the development and character of Newton's theology, adding a note on Arius and Socinus This part of the introduction is especially helpful to the layman not familiar with the theological controversies associated with Arianism and Socinianism and which deny the orthodox doctrine of the Trinity Newton's zeal for Protestantism is evident in his writings on Scripture, Church history and Christian doctrine. Among the manuscripts included in Dr McLachlan's volume are "Irenicum—or Ecclesiastical Polity tending to Peace", and several on religion As might be expected from Newton's Unitarian interests, there is a manuscript in which special attention, in the form of "Queries", is directed to the word "homoousios" and the meaning of the Nicene Creed The longest manuscript concerns the morals and actions of Athanasius and his followers

General and Scripture indexes are provided, the presentation of these hitherto unpublished MSS of Newton has been made possible by the Hibbert Trustees H D ANTHONY

### The Yellow Wagtail

By Dr Stuart Smith (New Naturalist Monograph) Pp xiv+178+12 plates (London and Glasgow Wm Collins, Sons and Co, Ltd, 1950) 12*s* 6*d* net

THE yellow wagtail (*Motacilla flava flavissima*) is a sub-species (confined almost entirely to Great Britain) of a species which is widely distributed in the Old World It was not until 1832 that Gould separated the yellow wagtail from the blue-headed wagtail, which, in its winter quarters, considerably outnumbers the yellow wagtail As many as twenty sub-species of *Motacilla flava* have been separated The yellow wagtail is a local bird in Britain, in Scotland the valley of the Clyde is its headquarters It no longer nests in districts from which it used to be reported, it does not apparently nest in the Hebrides (how many readers will recognize these Western Isles in the author's name "Ebudes" ?), although at one time it bred on Raasay In northern England the bird has increased, but in the south of that country it has generally decreased It has now entirely disappeared from Eire as a nesting species

Dr Stuart Smith has devoted long and arduous research to his subject, and has brought to light much valuable information regarding this small and attractive bird, which is a summer visitor to the British Isles and winters in West Africa, where the allied sub-species, the blue-headed wagtail, also winters This book has an added interest and value in that it is illustrated, besides by the author's photographs, by twenty-six reproductions of paintings by Edward Bradbury, paintings which combine beauty with accuracy The work is of the same high standard of production which characterized the earlier books of the New Naturalist series

SETON GORDON

### Genes, Plants and People

Essays on Genetics By C D Darlington and K Mather Pp xxi+187 (London George Allen and Unwin, Ltd, 1950) 16*s* net.

THE title of this book seems to have been chosen with at least one eye on the intelligent general reader who feels that he does not know much about genetics, but hopes that the book will help him to find a trail through a technological jungle in a *terra incognita* This class of reader will be sadly disappointed, for the book consists of a series of mainly professional essays, the earliest of which was written in 1929 and the latest in 1945 In addition, there is an article on Soviet genetics, with particular reference to the Lysenko affair, reprinted from *The Nineteenth Century and After*

These essays are not, as the jacket suggests, "scattered in many journals", since twelve out of sixteen are reprinted from *Nature* Can the reprinting of such a series of essays in an unmodified form be justified ? Some of the essays the authors might want to leave alone They might hold that the last word has been said But in a discipline which is above all dynamic and not static, it is pretty certain that an essay written last year is likely to be more valuable than one written some years ago

Serious workers would, however, be well advised to get the book, first, because for them it is a great convenience to have the essays in book form, and secondly, because they are significant milestones in the history of genetics S C HARLAND

### Modern Plastics

By Dr Harry Barron Second edition, revised Pp xx+779 (London Chapman and Hall, Ltd, 1949) 50*s* net.

ACCORDING to the preface, the object of the author is to present an overall view of the plastics industry to a reader possessing a modest scientific and engineering background The subject has been described under the main headings of raw materials, thermosetting resins, cellulose plastics, vinyl plastics, other plastics like nylon, casein, etc., the analysis and testing of plastics Included in this second edition are details of German practice as obtained from C I O S and B I O S reports, and also a chapter on the silicone resins, but there are some omissions, for example, the polytetrafluorethylene plastics

Technological aspects of the manufacture of plastics are fully described, and the reader is assisted by many good diagrams and illustrations of plant The style is of a popular character which results in a somewhat superficial treatment of the chemistry of polymers, but there is little doubt that the author has in great measure achieved his object.

# THE FUNCTION OF THE UNIVERSITIES

By the RIGHT HON LORD LINDSAY OF BIRKER, C.B.E.
University College of North Staffordshire

READERS of *Nature* will have seen accounts of the opening of the new University College in North Staffordshire, the constitution and syllabus of which are very largely experimental. It is one practical result of all this fermentation and discussion about universities which has been going on in recent years, notably in Great Britain and in Germany and in America, and before I try to give any account of this new experiment, I should like to offer some suggestions as to the reasons for this widespread discussion about the function of the university.

The discussion has been going on in one form or another for some time. There was a very remarkable little book published by the Student Christian Movement Press written by Adolf Lowe, as he was then known, called "Universities in Transformation". It was largely an account of the reasons which had led to what was in his opinion the degeneracy of the universities in Germany, and a warning that the same crisis would sooner or later appear in Britain. Since then there have been many other books and discussions, culminating, of course, in Sir Walter Moberly's widely discussed book, "The Crisis in the Universities".

There are some very general reasons explaining this world-wide trouble about the function of the universities. It is due, I think, in great part to two revolutions which have profoundly affected society in all kinds of ways: one I should call the technological revolution, and the other the democratic revolution. The importance of the technological revolution in the development of universities in the past hundred and fifty years is this. Before that time, the vast amount of industrial production done in Britain was the result of customary skills. University education was confined to what used to be called 'the learned professions', professions which could not be carried on without a good deal of book learning and a certain amount of science. Within the past hundred and fifty years, the importance of scientific investigation for industry and production has been steadily increasing. The result of this is that the standard of life in the modern industrial State depends to a large extent upon the standard of its scientific investigations, and the extent to which the results of scientific investigation become available to, and can be understood by, a great mass of the population. Where production is dependent upon customary skill, we learn things as they have been done. There are, of course, new inventions and discoveries, but the main task of society is to see that these acquired skills are not lost, but are handed on. In a society dominated by the spirit of scientific research, on the other hand, men are always considering whether what is accustomed to be done cannot be done better, whether its beliefs and traditions and customs ought not to be revised.

The universities do not now exist only to hand down learning. More and more it is their business to instil into their students a spirit of scientific research, a way of handling problems, the principle of investigation. Their students, of course, are to be taught what is already known and believed; but they are also to be taught to think and discover for themselves. This spirit of thinking for oneself is not now needed only in the learned professions: on the contrary, it is needed throughout industry. The height of a nation's technical achievement depends upon the height of the standard of its scientific teaching, and how widely the spirit of scientific investigation, as I have described it, is spread throughout the population.

It is possible, of course, to use the increasing power of scientific investigation in either of two ways. We may raise the standard of technical knowledge and technical invention and discovery in a few, and depress the standard of craft in the many. This is an only too possible but an evil way of using the new power of science. Or we may try to bring it about that the spirit of scientific research may spread in various degrees throughout the whole nation. We shall have to replace craftsmanship with the spirit of scientific research.

This all means that our technical efficiency and progress as a nation depend, as they have never done before, on the scientific standards of our universities and upon their accepting the very usual, and I think proper, conception that a university student is to be taught to think for himself. He needs to be able to originate and invent and discover. It also means that somehow there must be close links between the university and the great mass of the population. We are to become a nation of specialists, and yet we must somehow overcome the comparative isolation in which a specialist has to be by reason of his specialization. For this has all to be connected with the democratic revolution, and the democratic revolution repudiates the notion that power shall be confined to a small and privileged ruling class.

In the nineteenth century the ruling class in Great Britain were mostly educated in the ancient universities, and their needs produced a very interesting general education—the Arts Honours Schools—of which the most famous was Oxford Greats. That was at one time thought to be the ideal education not only for politics and the Civil Service, but also for such professions as the Church and the Bar. The other Arts Schools, both at Oxford and Cambridge, fulfilled more or less the same purposes. But this has meant that the politician and the Civil servant have received an education in which there has been little science, and there is an increasing demand in many quarters that politicians and Civil servants should know more of science. On the other hand, science has become so specialized that most of those who have done an Honours Science School know nothing of politics, and have been taught very little of the nature of government and of the system of values on which our civilization depends.

One solution, of course, of this difficulty is that which was taken by Hitler, that we should train men for government with the sort of general education which has been evolved in Great Britain, but with more emphasis perhaps on political institutions, and use other institutions to produce the technical expert. The technical expert in this plan is not supposed to know anything about politics because he is not supposed to take any part in government: he is just a very skilful instrument to carry out the purposes of the specialist ruling class. That is not a solution which could possibly be accepted by people in Britain, and clearly, if we accept the need for the scientific specialist and for technical skill of the highest grade, we must somehow combine that with general education which will give all students some understanding of cultural values and of politics I think that if we are to be both an efficient and a democratic nation, that is absolutely essential

Of course, the understanding of cultural values, politics and economics, which the student whose speciality is science requires, cannot be very profound, but it is not unreasonable to hope that all such men who come out of British universities should have some general understanding of our culture and institutions as well as some special and expert scientific knowledge

It is interesting that the institutions which seem to me to have grasped and to some extent grappled with this problem are the technical universities of Europe and the great technical institutions like the Massachusetts Institute of Technology and the California Institute of Technology When I was in Germany two years ago, I found that all the great technical universities of Germany that we saw were demanding that they should have what is called in Germany a "Philosophical Faculty", and that every student in his first two years should take courses in that faculty whatever his technical pursuit was going to be Both the American Institutes insist that all their students do what we should call Arts subjects as well as technical ones

We in Great Britain have suffered from specialization as much as anyone else, if not more, especially in the separation between students of science and students of the humanities Various attempts have been made recently at many of our universities to correct this extreme specialization, but in my view the disease is much more desperate than such mild remedies can deal with

Two things I think are needed

(1) Technical universities on the lines of the Massachusetts Institute of Technology and the Technical College of Zurich, which would insist upon some arts or social studies training for everybody

(2) A widened B A degree for all students who hope to be teachers, to go into the Civil Service, or politics, or some social service or business career, which would ensure that men who had a training for these special jobs in society have a training both in science and in arts

Our experiment in the new University College of North Staffordshire is meant to deal with this second proposal, and I may be able to explain how we are trying to do this on another occasion

# THE CAMEROONS TRUST TERRITORY*

WHEN the major part of the former German Cameroons became a French mandate after the First World War, a small strip where the ties of the populations were with their neighbours in Nigeria was allocated to Britain as Mandatory Power This is now administered as a Trust Territory It consists of two sections with a gap of some thirty miles between them Each is administered as a part of the contiguous region of Nigeria Although the Trusteeship Council has complained that this arrangement, which is in full accord with the provisions of the trusteeship agreement, hampers it in its task of supervision, it is the only practicable method for such small areas, and the integration of populations in the Cameroons into native authority units across the Nigerian border represents exactly that re-uniting of divided peoples which the original division of the territory was intended to achieve

To the student of administration this integration has some fortunate practical consequences The administering authorities of Trust Territories are required to present their reports to the Council in the form of replies to an exhaustive questionnaire This covers certain topics which the reader of the usual Colonial annual report is expected either to know already or to take for granted—notably the legislative basis and historical background of the present position with regard to such matters as taxation and the administration of justice On these subjects anyone interested in Nigeria as a whole can find an admirably full statement in the Cameroons report Again, the plan illustrating the administrative structure of the territory applies equally to the northern and eastern regions of Nigeria The section on education includes the curricula for all types of schools, and a full account of the new Education Ordinance, with special detail on the provision for grants-in-aid The section on international relations gives the final resolutions of the African Regional Scientific Conference at Johannesburg and the Jos Land Utilization Conference, and a summary of the findings of that on indigenous rural economy, also held at Jos There is also a valuable summary of the conclusions of the Colonial Office mission on the mechanization of agriculture The Native Authority estimates published in the appendix, though confined to the Native Treasuries situated in the Trust Territories or belonging to units in which Cameroons natives are incorporated, are valuable as illustrative material for the study of the native administration system throughout Nigeria

The Trust Territory itself has one feature which makes it unique in British West Africa, namely, the presence of extensive areas of land cultivated on the plantation system The land in question was originally alienated under German rule The plantations were auctioned after the First World War as part of the liquidation of ex-enemy property, the greater number were repurchased by their former holders In 1946 they were bought by the Nigerian Government from the Custodian of Enemy Property to be "held and administered for the use and common benefit of the inhabitants of the Territory" They were leased to the Cameroons Development Corporation, a body created to manage them All the profits are "applied for the benefit of the inhabitants of the Trust Territory in such manner as the Governor may determine" The Corporation's second annual report is included among the appendixes to this volume It employs on its forty-nine plantations a labour force of about 18,000, with a staff of 74 Europeans and 368 Africans It has its own medical staff, three hospitals and a training school for nurses, and pays the cost of buildings and equipment for schools to be managed by missions or the local Native Administration

In the Victoria Division, where these plantations are situated, the land in native occupation consists of 'reserves' marked off around the villages The inhabitants have petitioned the Trusteeship Council with a complaint that these are inadequate. After an investigation, the findings of which are published as an appendix, it has been agreed that an area of 25,000 acres should be released from the plantations and be offered in 15-acre plots on controlled-tenancy terms, with technical assistance, a guaranteed market for approved crops and social welfare services provided by the Corporation. As the acute population pressure is due partly to immigration—in 1948 there were 9,515 immigrants among an indigenous population of 15,000—this will have to be controlled in future. The investigating officer insists that "what is required is nothing less than a full campaign of community development concerted between the peoples themselves, the Administration and the Cameroons Development Corporation, aiming at the social regeneration of the clan and the spreading of a new interest in agricultural advance, coupled with the development of an aptitude for good husbandry". He makes various recommendations to this end.

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* Colonial Office Report by H M Government in the United Kingdom of Great Britain and Northern Ireland to the General Assembly of the United Nations on the Administration of the Cameroons under United Kingdom Trusteeship for the Year 1949 (Colonial No 262 ) Pp xvi+384+8 plates (London H M Stationery Office, 1950 ) 10s 6d net

The report contains a number of extracts from reports of the Trusteeship Council and the visiting mission which went to the Cameroons in November 1949; this consisted of an Iraqi, a Belgian, a Mexican and an American. It is interesting to compare the comments of the two bodies. The latter shows a genuine appreciation of the practical position, and even urge an increase for the present in the staff of "European administrators and technical officers available to perform the functions of advisers and teachers". In its view, shortage of staff is a limiting factor on the pace of advance towards self-government. It also singles out for commendation the wide freedom of speech allowed in the Territory.

The usefulness of the report for reference would be increased if the numbers of pages as well as paragraphs were given in the index.

L. P. MAIR

# DIRECTION OF ARRIVAL OF IONOSPHERIC RADIO WAVES

By W. ROSS
National Physical Laboratory

## Early Experiments on Medium Wave-lengths

AMONG the earliest attempts to measure *directly* the direction of arrival, in either the vertical or horizontal plane, of radio waves reflected at the ionosphere were those made about the year 1925 by Appleton and Barnett[1], and by Smith-Rose and Barfield[2]. Of the methods used by these workers, the most important was possibly that in which the angle of incidence in the vertical plane was inferred from a comparison of the intensities of the signals induced by the down-coming waves in a vertical open aerial, and in a vertical loop aerial oriented in the assumed plane of propagation. The mean angle of incidence so measured agreed well with that deduced from the theory of symmetrical reflexion at a postulated reflecting layer some 100 km high. This was for medium-wave broadcasting stations. Large variations (of the order of ± 15°) in the apparent angle of incidence were observed, and these gave rise to some speculations. The investigators were aware that, if the assumption that propagation was confined to the vertical plane between the transmitter and the receiver was not true, the values of angle of incidence deduced from the loop and aerial comparisons would be in error, and indeed Smith-Rose and Barfield carried out experiments with Adcock-type direction-finders which tended to show that if any lateral deviation did exist it did not exceed a degree or two in magnitude. They appear, however, to have overlooked the point that a small amount of lateral deviation combined with a rotation of the plane of polarization can give rise to very large spurious variations in apparent angle of incidence in the simple loop and aerial method of measuring angle of incidence.

Two years later, Appleton and Ratcliffe[3], and Smith-Rose and Barfield[4], still using the same method, recorded further measurements of angle of incidence. Appleton and Ratcliffe commented particularly on the large and very rapid fluctuations in apparent vertical angle, and concluded that these did not represent true variations in height of reflexion but were due rather to reflexions at different points in a layer of constant height, that is, diffractive reflexion. This appears to be the first mention in the literature of the effects on apparent direction of arrival which could be caused by ionospheric irregularities or roughness. The authors referred to the possibility thus introduced of lateral deviation of the waves from the great-circle plane, but do not appear to have considered in detail how such lateral deviation would affect the apparent magnitude of the changes in angle of incidence which they observed. As will be seen from later references, it is now almost certain that, while the explanation which they offered of 'angle-flicker' is correct, its true magnitude was not so great as they observed and, in fact, their measurements were in error because the assumption implicit in the single-loop and vertical-aerial method that there is no lateral deviation of the waves is not in fact true.

Some time later, Cherry and Martyn[5], working in Australia, carried out experiments similar to those described above, and again observed the large and rapid apparent 'angle-flicker'. They concluded that Appleton and Ratcliffe's explanation in terms of reflexion from different centres of reflexion in the same horizontal plane would require such large variations in equivalent path-length to account for the apparent angle changes observed as to make this explanation unlikely. They favoured interference between waves reflected at layers at different heights ($E$- and $F$-layers). They were not then aware of the large errors due to lateral deviation which have been referred to already.

The matter was very much clarified in 1935 by Martyn and Green[6], who showed that if lateral deviation of the waves occurred along with rotation of the plane of polarization, deductions made from comparison of a single loop and aerial were liable to large errors. Using two loops at right angles along with a vertical aerial, they were able to measure both the azimuth and angle of incidence of the received waves. They were able to show that the real variations in angle of incidence of an $E$- or $F$-layer echo, for example, were of the order of ± 1–2° instead of the ± 20–30° obtained from a single loop and aerial. They concluded that the *large* 'angle-flicker' noted by Appleton and Barnett and subsequent workers was not a real effect. Some variation in angle of incidence did occur, but it was much smaller than the early workers had believed they had observed. Martyn and Green, however, by measuring both lateral deviation and angle of incidence, showed that the explanation offered by Appleton and Ratcliffe in 1927 was correct, though based at the time on spuriously large angular variations.

A little before this paper by Martyn and Green appeared, Ratcliffe and Pawsey[7] had published the results of other investigations which, using, in part, different methods from those described above, had appeared to confirm the earlier conclusions about lateral deviation. By comparing the fading on similar aerials at various separations, they concluded that "when the separation is of the order of one wave-length signal variations are largely uncorrelated" This was on medium wave-lengths (250–350 m approximately) Their paper does not say precisely what "largely uncorrelated" means, and the records which they included by way of illustration suggest that there is certainly partial correlation at one wave-length However, on the basis of the above statement, the authors concluded that deviations of angle of incidence up to 25° must commonly occur Using what was in effect a single Adcock aerial pair, they also made measurements of lateral deviation They were aware of the effects of polarization errors in this type of measurement, but some of the tests which they applied to demonstrate the absence of such errors (for example, by short-circuiting the aerials) are invalid It would now be admitted that, for the comparatively small angle of incidence to the vertical which was involved (25°), polarization errors were probably substantial The fact that close correlation was obtained between the indications on the lateral deviation receiver and the intensity variations of the down-coming ray neither proves nor disproves that true lateral deviation was being observed

## Extension to Shorter Wave-lengths

All the work to which reference has so far been made applied to medium wave-lengths in the range 200–500 m approximately and mostly to *E*-layer reflexions, though Martyn and Green[6] included some results for *F*-layer reflexions showing that, on 200 m, *E*- and *F*-layer reflexions behaved similarly as regards angular deviations

In 1935, T L Eckersley[8] published a paper describing the results of investigations on shorter wave-lengths (30–40 m approximately) and largely referring to *F*-layer reflexions Using apparatus capable of high precision, he showed that the rays reflected at the normal *E*- and *F*-layers possess a small angular spread of one or two degrees He was chiefly concerned with the rapid, that is, second to second, fluctuations, and was of the opinion that these were all due to one cause, namely, scattering centres in the *E*-layer Although some of the results quoted appear to show evidence of slower angular changes, that is, variations having periods of a few minutes or even longer, he did not direct attention to this and may not have been aware of their significance In passing, it may be mentioned that one example quoted by Martyn and Green (ref 6, Fig 6*B*) also gives some indication of a rather slower angular change superimposed on more rapid fluctuations A later paper, also by Eckersley[9], extended somewhat the information contained in his earlier papers Again the results were intended to apply to rapidly varying angular deviations

In 1938, Barfield and Ross[10] described the results of direction-finding measurements made with an accurate spaced-loop system In this paper, for the first time apparently, a distinction was drawn between rapid (that is, second to second) and slow (that is, minute to minute or longer) variations The authors clearly showed that, for nearby stations and using pulsed signals, there were, in addition to the rapid changes in direction, very much slower changes with periods ranging up to 10 or 20 minutes or more They ascribed the latter to slowly varying ionospheric tilts The results quoted apply solely to *F*-region reflexions on frequencies between about 4 and 10 Mc/s

In practically all the earlier papers, lateral deviation had been thought of as a rapidly varying phenomenon ('angle-flicker'), and after the paper by Appleton and Ratcliffe[3] it had been ascribed to the results of ionospheric 'roughness', that is, to effects of wave interference within a cone of rays constituting a single 'ray' The paper by Barfield and Ross[10], however, may be considered to have established the existence of much more persistent, though still more or less random, angular deviations due to large-scale and rather slowly varying ionospheric irregularities

## Indirect Evidence of Ionospheric Tilts

At this point, reference must be made to a paper by Pierce and Mimno[11] which does not appear to have attracted the attention which it merits in connexion with the deviations experienced by ionospheric reflexions They described results which can be observed at vertical incidence and which appeared to show the existence of very long 'wave-length' variations of ionospheric density or height of quite small magnitude For example, typical results could be explained on the assumption of a variation of ionospheric height (*F*-layer) of ± 2 km with a 'wave-length' (that is, distance between points of maximum or minimum height) of about 200 km These very long wave-length disturbances were shown to travel with a speed of about 600–800 km/hr, which is stated to be about the velocity of sound at these levels It was therefore tentatively suggested that they were hydrodynamical compression waves in the atmosphere at the *F*-layer height

It is to be noted that such variations as were suggested, namely, ± 2 km height with a 'wave-length' of 200 km, give a maximum effective slope of the layer at any point of 4°, and this, together with the rate at which the disturbances travel, appears to show that they are, in fact, the "slowly varying tilts" of the layer described by Barfield and Ross[10]

In 1941 there appeared the summary of a paper by Eckersley and Farmer[12], of which the full text was not published until 1945, owing to war-time restrictions This paper, which was again concerned principally with rapid changes, confirmed and extended Eckersley's earlier results[8,9] Slowly varying changes were not explicitly referred to, but it is clear from certain results that are given that they were present

## Recent Measurements of Ionospheric Tilts

In the meantime, the lateral deviation of high-frequency waves was being continuously studied at the Radio Research Station, Slough, and the evidence supporting the existence of both rapid and slow variations had accumulated For *F*-layer reflexions at frequencies above about 3 or 4 Mc/s, it is now quite clear that the two types of variation arise from what have to be regarded as different causes. The rapid fluctuations are apparently due to wave interference effects resulting from the 'spreading' of the ionospherically reflected wave into a cone of radiation, this being due to 'roughness' of the reflecting layer on a comparatively small scale. The slower variations have to be pictured as being due to movement of the whole cone of radiation under the influence of some very long wave-length ionospheric irregularities The layer at any point can be considered to be subject to a continuously varying degree of tilt, the period of variation ranging from a few minutes up to half an hour or more The results of these studies carried out over a period of some ten years were recently published in a special report[13] The standard deviation of the slowly varying ionospheric tilt has been shown to be of the order of 1½–2° under normal conditions

The report also contains evidence of the direct measurement of the systematic tilt which must be presumed to exist at special times such as during the sunrise period This 'sunrise tilt' is also described in an earlier note by Ross and Bramley[14]

Up to this time, the scale of the ionospheric irregularities causing the slow tilts had been the subject of speculation Pierce and Mimno[11] suggested a 'wave-length' of 200 km or more, and Ross[13] concluded that the linear dimensions (in the horizontal plane) of the irregularities must be at least of the order of 20–30 km and may be even larger In order to provide some direct observations on this point, it was decided to make simultaneous measurements with two direction-finding stations separated by several kilometres The first published results of such experiments by Ross and Bramley[15] show that striking correlation of bearing changes is obtained with receiving stations 10 km apart This work is being continued and extended and is to be described in a future paper It has been found that with receiving stations 27 km apart there is extremely close correlation in the slowly varying components of angular deviation, which seems to be direct evidence that the scale of the irregularities is of the order of a hundred kilometres or more as originally suggested by Pierce and Mimno

## Measurements of Tilts by Direct Measurements of Ionospheric Height

It is relevant at this point to refer to recent work by a number of Australian workers who, using vertical incidence ionospheric recorders, have observed certain phenomena which are almost certainly linked up with the 'slowly varying' ionospheric tilts referred to above Gipps, Gipps and Venton[16] comment on 'split traces' and apparent 'doubling' of ionospheric echoes, which appear to be due to the appearance of bumps and concavities on the $F$-layer Munro[17–19], in recent communications, also describes irregularities in vertical incidence records These he suggests are due to "very long wavelength ionospheric disturbances which appear to exhibit both vertical and horizontal progression" He favours an explanation of these effects in terms of a pressure wave, that is, similar to the explanation offered by Pierce and Mimno[11] Similarities in the disturbances observed at Sydney and Canberra (237 km apart), together with the time difference between the effects, provide evidence both as to the wave-length of the disturbances and their rate of travel Although Munro calls the effects "short-period changes", the rate of change corresponds to what Ross has called the "slowly varying ionospheric tilt" To those concerned with high-frequency direction finding, changes with a period of several minutes or more are comparatively slow as contrasted with the moment-to-moment changes also present, but to Munro, thinking no doubt in terms of the usual diurnal and longer-period ionospheric changes, variations with a period even of 20–30 min are 'short-period' changes

The magnitude of the tilts corresponding to some of the results described by Munro are substantially larger than the average values given by Barfield, Ross and Bramley For example, Munro singles out an occasion on which a tilt of up to about 30° occurred. This difference, however, can be explained largely by the fact that the Australian methods of investigation, involving as they do a study of vertical incidence $h'/f$ records, are likely to be somewhat insensitive to the smaller effects Only the exceptionally large effects attract notice, and of these the most striking have been selected for detailed analysis The methods used by the workers in Great Britain, on the other hand, involving sensitive direction-measuring apparatus, are capable of detecting the smaller irregularities, so that the tendency there has been to describe the average rather than the exceptional cases In fact, exceptionally large tilts, many times the root-mean-square value, have, at times, been observed The similarity of periodicities seems to show that both groups of workers are, in fact, observing the same phenomenon

Martyn[20] has very recently given a theory for the propagation of disturbances in the upper atmosphere which appears to be capable of fitting the experimental results obtained, for example, by Munro It seems fairly certain that the hydrodynamical theory of these disturbances is correct

## Studies of Fading'

The effects of roughness of the ionosphere in causing reflexion to be more of a diffractive process than true specular reflexion have continued to be studied by a number of workers, notably those of the Cambridge school under Ratcliffe[21–26] A number of important papers on this problem have appeared recently, and these add greatly to the understanding of the rapidly varying effects, that is, fading as normally understood, and the rapid angular changes In particular, through a study of records of fading it has been possible to arrive at much closer estimates of the angular spread of typical echoes Average values are of the order of a few degrees for echoes from $E$- and $F$-layers and frequencies in the range 2–5 Mc/s There is evidence that the angular spread diminishes at higher frequencies, in conformity with the results of Eckersley and of Barfield and Ross

Furthermore, comparison of the fading experienced at neighbouring points has shown that fading is often predominantly due to an apparent translation of an irregular ionosphere past the observer—referred to as an ionospheric 'wind' It may be, however, that these 'winds' are but another aspect of the very-long-wave compression waves in the upper atmosphere to which reference has already been made

## Conclusions

So far as irregularities in the propagation of high-frequency waves are concerned, more especially when the $F$-region is concerned, it is now quite clear that there are two phenomena involved There are the comparatively small-scale irregularities giving rise to fairly rapid fading and angular spread or angular 'flicker' of a few degrees, and the larger-scale irregularities giving rise to very much slower angular changes and perhaps slight, but not marked, slow intensity variations as well

This survey was prepared as part of the programme of the Radio Research Board, and this article is published by permission of the Department of Scientific and Industrial Research

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# OBITUARIES

## Dr G A Hankins

Dr George Alexander Hankins, director of mechanical engineering research in the Department of Scientific and Industrial Research, died suddenly on November 2 at the age of fifty-five He was born at Portsmouth on April 25, 1895, on leaving school he entered H.M. Dockyard there as an apprentice engine-fitter From the Royal Dockyard School, where he obtained a Whitworth Exhibition and a Royal Scholarship, he proceeded to the Imperial College of Science and Technology

During the First World War, Hankins served for a year in the Royal Garrison Artillery, but in 1916 he returned to Portsmouth Dockyard as an inspector of materials and gun mechanisms A year later he joined the scientific staff of the Engineering Division at the National Physical Laboratory, and remained there until February 1948, for the last three and a half years as its superintendent Before relinquishing this post, he had, in May 1947, been appointed first director of mechanical engineering research in the Department of Scientific and Industrial Research As such it was his task to establish and control a new organization to take over the majority of the Engineering Division's work and to expand it some six times, with an eventual staff of more than six hundred Under his leadership a firm foundation has been laid, research committees have been set up, staff have been appointed to the key posts and a start has been made on the building of new laboratories at East Kilbride, near Glasgow Such an undertaking, at the present time, is fraught with difficulties, and it is probable that the energy he put into it contributed to his early death It is indeed tragic that he did not live to see the fruition of his labours

In the inter-war period, Hankins was responsible first to the late Sir Thomas Stanton and later to Dr H J Gough for many engineering researches, mainly on strength of materials His work on hardness testing led to the award in 1928 of the degree of D Sc (Eng) of the University of London He made valuable contributions to the study of fatigue of metals, particularly the effect of surface conditions on the fatigue resistance of spring steels In 1935 he was awarded the Crompton Gold Medal of the Institution of Automobile Engineers for his work on deep-drawing Later, his investigations of the strength of welds had much to do with the application of welding both to steel structures and to pressure vessels

During the Second World War, Hankins's abilities in the organization of engineering research had full scope in connexion with, among many other projects, flame throwers, gun springs and PLUTO The achievement in this direction of which he was justly, proudest was, however, the design and construction of the only large supersonic wind tunnel available to the Allies during the War His experience was utilized on many committees In 1944 he succeeded Dr S L. Smith as superintendent of the Engineering Division of the National Physical Laboratory, and directed the post-war re-equipping of the Division

Hankins was a member of the Institutions of Civil and of Mechanical Engineers, and for three years was a member of the Council of the latter He was invited by the North East Coast Institute of Engineers and Shipbuilders to give the Laing Memorial Lecture in 1943, and by the Institution of Mechanical Engineers to give, with Mr E F Relf, one of the Centenary Lectures in 1947 D G Sopwith

## Sir Ernest Graham-Little

Born in 1867, the son of Mr Michael Little, of the Indian Civil Service, and Anna English, of Cape Town, Ernest Gordon Graham-Little was educated at the South African College, taking his B A at the University of Cape Town, winning a gold medal and a Porter Scholarship Then, coming to Britain, he took up a medical career and entered at Guy's Hospital, where he graduated M B (Lond) with honours in 1893, taking his M D in the following year For several months he studied skin diseases in Paris, the subject which ultimately became his life's specialty, though he dallied with general medicine at St George's Hospital for a time, and became physician to the East London Children's Hospital at Shadwell In 1902 he succeeded Sir Malcolm Morris as dermatologist to St Mary's Hospital, having previously won the membership of the Royal College of Physicians, and being elected to the fellowship in 1906 In 1911 he married Miss Helen Kendall, by whom he had a son and a daughter, but both their children were lost in early adult life, the daughter by drowning in 1931 when bathing in a rough sea at Saltdean, and the son on active service in 1942

Graham-Little in his earlier years did a great deal of work for dermatology, and was a favourite teacher of this subject at St Mary's, writing numerous papers on this subject, and being elected president of the Dermatological Section of the Royal Society of Medicine, and also of that Section of the British Medical Association for the year.

He was a close friend of Russell Wells, vice-chancellor of the University of London, and was elected a member of the Senate in 1906, a post he retained until May this year In 1922 he became president of the University Graduates Association, an honour which no doubt greatly helped him in a keen triangular contest in 1924 to be member of Parliament for the University, which he represented as an Independent Conservative until all university seats were abolished recently. He was most assiduous in his attendance at the House of Commons, and was a frequent contributor to debates involving medical principles, and by letters to the Press, becoming chairman of the Medical Parliamentary Committee in 1943 Retiring from his post of physician for skin diseases at St Mary's in 1934, he had more time for his political work in the House of Commons He was largely responsible for the recognition of the West London Hospital by the University as an institution for the admission of women as external students

Hard fighter as he was in the House and in the University Senate, in pushing for reforms he believed in, yet in private life Graham-Little was kind and always ready to help students with advice, and was a most interesting conversationalist among his friends at dinners or club meetings Although during the last few years his failing eyesight severely limited his activities in public, yet with the help of his devoted wife he followed the controversies of the day, notably the National Health Act, with the greatest keenness, and his letters in the daily Press were a frequent source of pleasure to his friends and supporters in opposition to ministerial autocracy in the National Health Service.

The large attendance of medical and other friends at the memorial service at St Peter's, Vere Street, on St Luke's Day, were surprised and delighted by the charming, short and friendly discourse given from the pulpit, regarding his friend Graham-Little, by the Rev Scott Lidgett, a 'young' veteran of ninety-six WILFRED HARRIS

We regret to announce the following deaths

Captain E B H. Cunnington, for many years honorary curator of the Wiltshire Archæological Society's Museum at Devizes, aged eighty-nine

Mr Percy Good, C B E, director of the British Standards Institution since 1942, on December 2, aged seventy

Prof J Share Jones, M B E, emeritus professor of veterinary anatomy in the University of Liverpool, on December 2, aged seventy-seven

Dr Hans Robert Landolt, who had worked at the Royal Institution, London, and the Department of Colloid Science, Cambridge, on the physical chemistry of muscle proteins, on November 30, aged thirty-two

Dr J A Murray, F R S, during 1915–35 director of the Imperial Cancer Research Fund, on November 20, aged seventy-six

Brigadier Sir Edward Tandy, formerly surveyor-general of India, on November 30, aged seventy-eight

# NEWS and VIEWS

## Yerkes and McDonald Observatories Prof B Stromgren

PROF BENGT STROMGREN, director of the University of Copenhagen Observatory, Denmark, has been appointed a professor of astronomy and chairman of the Department of Astronomy and Astrophysics in the University of Chicago, and director of the Yerkes and McDonald Observatories As he is to retain for the present the directorship of the Copenhagen Observatory and to spend three months each year in Denmark, it can be seen that he is to carry a heavy load of work, and it is not surprising to learn that he will be resigning next year from the post of general secretary of the International Astronomical Union But the opportunities opened up to him in his new position were too great and important to be refused They have been well earned, for Prof Stromgren's work in astrophysics on the structure of stellar atmospheres, and on interstellar space, has placed him among the world's leaders in this branch of science For his researches he was recently awarded by the vice-chancellors of the Universities of Denmark the first Augustinus Prize of 50,000 Danish kroner He will be no stranger when arriving in Chicago, as he has visited the University and its observatories in the past and worked there with Prof O Struve His many friends all over the world welcome the appointment and are confident of the success with which he will carry out its many duties

## International Research Centre for Chemical Microbiology, Rome

THE United Nations World Health Organization with the consent of the Italian Government, has recognized the Istituto Superiore di Sanità (Higher Institute for Health) in Rome as an International Research Centre for Chemical Microbiology The Institute, under its director-general, Prof Domenico Marotta, is one of the largest research centres in Italy, and its laboratories are among the most modern and best-equipped in Europe The research departments include physics, therapeutic chemistry, biochemistry, malariology and bacteriology, and it also contains the main food and drug control centre of the Italian Government Recent extensions to the existing buildings of the Institute will be used to house the newly created International Centre for Chemical Microbiology These extensions contain research laboratories as well as a fermentation pilot plant with fermenters up to a capacity of 18,000 l and all the processing equipment required for the isolation on an industrial scale of biologically interesting substances, such as antibiotics, enzymes, growth factors, etc Ample workshop facilities are also provided

The International Centre for Chemical Microbiology will be under the scientific direction of Prof E B Chain, formerly of the University of Oxford, joint winner of the 1945 Nobel Prize for Medicine for the discovery of the chemotherapeutic effect of penicillin and recently elected first chairman of the newly formed Experts Committee on Antibiotics of the World Health Organization Prof. Chain has been in Rome for two years organizing and directing a new research department of biochemistry at the Institute The Centre is built up of a number of different research units, including one for biochemistry and organic chemistry, one for bacteriology and mycology, and one for physical chemistry and microbiological engineering. The chief two aims of the Centre are: first, to provide facilities for research workers to become acquainted with the different methods of chemical microbiology, by working in one of the research units; and second, to make accessible for scientific investigations substances of microbial origin the isolation of which requires equipment of industrial dimensions not normally available in university laboratories. This Centre will be the forerunner of a number of others which the World Health Organization intends to set up in other parts of the world on a wide basis of co-ordinated research, and for which a number of fellowships are being financed. The realization of this project is an interesting example of the value of the schemes organized by the British Council for British men of science to visit foreign countries. In this case the project was the result of a lecture tour which Prof. Chain undertook in Italy for the British Council in 1947.

## Losses from Plant Diseases

THERE is, perhaps, a general reticence about the writing of papers which deal with losses from crop disease, yet, whenever dispassionate surveys are made, much useful information of a practical nature is obtained. Mr. W. C. Moore chose to speak on "The Significance of Plant Diseases in Great Britain" for his presidential address to the Association of Applied Biologists (*Ann. App. Biol.*, 36, No. 3, 295; 1949). Mr. Moore is head of the Plant Pathology Laboratory of the Ministry of Agriculture, Harpenden, and is therefore in a good position to digest the numerous reports on disease prepared by advisory officers. About a thousand different plant diseases are known in Great Britain, but fortunately only about forty are regarded as of economic importance. Some maladies, such as crown rust of oats, *Puccinia coronata*, white root rot of many plants, *Rosellinia necatrix*, and antirrhinum rust, *Puccinia antirrhini*, are much more serious in southern Britain than in the north. Take-all of cereals, *Ophiobolus graminis*, chocolate spot of beans, *Botrytis* sp., and *Didymella* stem rot of tomato are only severe in certain years. Looking to the future, Mr. Moore considers that gangrene of potato, *Phoma foveata*, leaf blotch of onion, *Heterosporium allii*, alternaria blight of tomato, *A. solani*, and ink disease of iris, *Mystrosporium adustum*, may well become more troublesome than in the past. He has, indeed, shown how *Sclerotium tuliparum*, the cause of grey bulb rot of tulips, has increased in distribution since 1922. The status of many other diseases is discussed, and the paper should lead students of plant pathology to that most important asset for their subject—a sense of proportion in assessing disease damage.

## Optical Properties of Solid Thin Films

AN international colloquium on the optical properties of solid thin films was held at Marseilles in April 1949 under the auspices of the Centre National de la Recherche Scientifique (see *Nature*, 163, 885; 1949), and the full text of the thirty-five papers presented, together with a short foreword by Prof. P. Rouard and a list of those who were invited to participate in the colloquium, is now available and appears in the July issue of the *Journal de Physique et le Radium* (11, 305; 1950). The national representatives who were invited were as follows: Dr. B. H. Billings, Mr. N. W. Scott, Prof. J. Strong and Dr. A. F. Turner (United States); Drs. K. M. Greenland, O. S. Heavens and H. Kuhn, and Prof. S. Tolansky (Great Britain); Drs. B. S. Blaise and P. van Alphen (The Netherlands); Dr. L. Ballerini and Prof. F. Scaldone (Italy); Dr. Schaetti (Switzerland); and Prof. A. Vašiček (Czechoslovakia). The papers are grouped together under five headings: theoretical investigations of the optical properties of thin films; the preparation of films, and various techniques; experimental investigations of the optical properties; applications; and bibliography. This last group consists of one paper by P. Cotton and P. Rouard, in which an excellent comprehensive survey is given of the literature on the subject of optical thin films and to which is appended some 250 references. Several of the papers are in English; these have French summaries. The remainder are in French, and the majority have English summaries. It is pleasant to note that each paper commences on a separate page. As Prof. Rouard remarks in his foreword, the work described will be of interest to others besides specialists, and shows clearly that French physicists, in addition to those of other countries, have made and are making important contributions in this important and rapidly growing field.

## New Tension Meter for Wires and Threads

THE Saxl Instrument Co., Harvard, Mass., has recently announced the development of a new and improved model of tension meter with a total capacity of 125 grams. This meter has applications not only in the textile field but also in the electrical field, wherever quick tension measurements on wires, filaments, thread, etc., are required. The new model has twice the sensitivity of the old 250-gm. model which is still being manufactured. In addition to instant trigger action and correct dynamical calibration under performance conditions, the meter is equipped with ball-bearings throughout, thus reducing roller friction to negligible dimensions. Special precision pulleys recessed in the trigger mechanism automatically guide the yarn into position, and gentle insertion and release are assured. For sensitive nylons and other fine yarn the first revolution of the dial giving readings on black figures up to 50 gm. suffices. The remaining part of the range, 50–125 gm., is read from red figures on the second revolution of the dial. Therefore, without special adjustments, the pointer can overtravel and continue to give precise readings even when the tension is above the 50-gm. range.

## Technology of a Modern Stone-Age People in New Guinea

THE methods used by prehistoric man to fashion his stone and bone implements have long been an object of speculation. Not all tools are chipped in the same way, and more than one way of shaping bone objects can be observed. While analogies must never be pressed too far, it is always interesting to know how a modern stone-age folk set about similar tasks. This is described in "The Technology of a Modern Stone Age People in New Guinea", by Beatrice Blackwood, a publication of the University of Oxford Pitt Rivers Museum (Occasional Papers on Technology, 3. Pp. 60+17 pl. 1950. 10*s*. 6*d*.). The author has lived many months in New Guinea, and the volume is the result of careful observation on the spot of the various techniques employed. The making of stone-bladed adzes, stone-headed clubs, wooden clubs, bows and arrows, bamboo knives, and bark cloth, and also fire-making are all described and illustrated There are not only a number of line drawings in the text, but no less than sixteen full-page half-tone illustrations grouped together at the end This third occasional paper on technology to be issued by the Pitt Rivers Museum is a very worthy successor of the two which preceded it

## Earthquakes in and around India

THE subject of earthquakes in India and neighbouring countries is reviewed by C G Pendse in Vol 10, No 129 of "Scientific Notes of the Indian Meteorological Department" (Earthquakes in India and Neighbourhood Pp. 177–220 (Delhi Manager of Publications, 1948 ) 1 14 rupees , 2*s* 9*d* ) For the period 1917–34 there were no notable earthquakes on the mainland of India or Ceylon south of latitude 20° N (which runs just north of Bombay) , but this area was almost surrounded by earthquake epicentres The area of most intense earthquake activity was undoubtedly that stretching north-eastward from approximately Kabul in Afghanistan and including the Pamirs Persia to the west had frequent earthquakes, and no part of it appears to have been free, though the activity was not quite so intense as in the Pamirs To the east of the latter, stretching into Tibet, the crustal instability of the earth was approximately the same as it was in Persia There was quite strong activity along a line a little north of latitude 25° N from near Dhubri and the Garo Hills eastward through Assam to about longitude 102° E This line of epicentres was at the junction of the 'Tibetan' seismic area and the well-defined ribbon of earthquake activity which stretched southwards through Burma, through the Bay of Bengal to include the Andaman Islands and on to join the East Indies arc at Sumatra Malaya and southern Siam were practically free from earthquakes Almost to complete the ring around India were three areas of moderate instability in the Arabian Sea (centre of zone near lat 13° N , long 56° E ), the Indian Ocean (lat 2° N , long 65° E ) and the Indian Ocean (lat 2° N , long 87° E )

## Northern Advisory Council for Further Education

THE third annual report of the Northern Advisory Council for Further Education describes the surveys which have been made of the educational requirements of a number of industries within the region , some of these have led to recommendations for the establishment of new courses at technical institutions Requests for these surveys have come from many sources, the main one being industry itself, the Council has been encouraged by the number of requests from industries which have only recently begun to appreciate the problem of the technical training of their employees Among items submitted to the Council by the Academic Board for Technology, Commerce and Art were statements on the problems involved in part-time release of young workers in industry and the release of teachers to industry and commerce Considering the respective merits of day-release and 'sandwich' courses, the Board submitted that the problem of release was not one that could be solved by the adoption of a uniform system throughout industry, and there was room for experiment with continuous systems of release Notwithstanding present staffing difficulties the Board recommended that every effort should be made to release suitable teachers for periods in industry and commerce , Durham University Appointments Board and the Federation of British Industries have indicated their willingness to help in making the necessary arrangements with firms Copies of the report may be obtained from the Secretary, 43 Eldon Place, Barras Bridge, Newcastle upon Tyne, 1

## Scientific Papers Published in the Middle East

THE fifth number of the "List of Scientific Papers published in the Middle East", which covers papers received by the Middle East Science Co-operation Office between October 1, 1949, and March 1, 1950 (No 5, June , pp 78 , Cairo Unesco Middle-East Science Co-operation Office, 1950), is not only larger than the earlier numbers but also differs in general outlay The List is now printed in two columns, so that entries can be cut out and pasted on standard index cards Titles are now given only under the heading relevant to the main contents of the heading , for other subject headings with which the article deals a reference to this section is inserted To simplify references, all titles have been numbered consecutively, and an attempt has been made to bring the abbreviations used for the different periodicals into line with those recommended by the International Federation of Standard Institutions Some doctorate theses have been included, and, as an experiment, abstracts or summaries published with the papers have been reproduced, where they do not exceed 150 words in length Although the List now covers a number of scientific periodicals not obtainable in the Middle East in 1948–49, no claim is made that the bibliography is yet complete in the sense of covering all work published in the Middle East Nevertheless, the changes introduced are likely to enhance considerably the value of the List to scientific workers and institutions within and outside the region

## *Journal of Atmospheric and Terrestrial Physics*

DESPITE the difficulties of finance and printing that nowadays beset scientific publication, Butterworth–Springer, Ltd , Bell Yard, Temple Bar, London, W C 2, have lately launched a new geophysical periodical, entitled *Journal of Atmospheric and Terrestrial Physics* (1, No 1, 1950, pp 64, complete vol (300–400 pp ), 70*s* ), initially publication will be bi-monthly The editor-in-chief is Sir Edward Appleton, and there is an editorial advisory board of twenty-four members drawn from twelve countries—as is appropriate to the intended international character of the *Journal*, which will publish papers in English, French or German (the first issue contains two papers in German, each with an abstract in English) The chief interests of the editor and his board include radio physics (seven members), meteorology, including atmospheric electricity (six members), geomagnetism and aurora (five members), solar physics (three members), cosmic rays and general upper-atmospheric physics (three members), oceanography (one member) , the almost total lack of editorial representation of subsurface geomechanics and geophysics (apart from geomagnetism) is paralleled in the contents of the first issue, which would be adequately described by the title of the *Journal* with the fourth and fifth words omitted It would be improper to infer the future composition of the *Journal* from one issue , but, as it is, this issue complements the only pre-existing London geophysical periodical, the *Geophysical Supplement to the Monthly Notices of the Royal Astronomical Society*, which has hitherto given far more space to subsurface terrestrial mechanics and physics than to atmospheric physics

### Abstracts on Agricultural and Horticultural Engineering

A NEW quarterly publication, *Abstracts on Agricultural and Horticultural Engineering*, has been started by the British Society for Research in Agricultural Engineering, and the first number has already appeared, obtainable from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (No 1, Spring 1950, pp 61, annual subscription, 16*s* ) The abstracts are being collected from a wide range of home and overseas publications and are usefully grouped under a variety of subjects Cross-references are provided for by an index, but some self-evident arrangement, alphabetical or otherwise, of the authors cited under each subject would add to the value of the publication Lists of the bulletins published by the Institute and appropriate publications issued by H M Stationery Office are also available on application to the above address

### The National Museums, Ceylon · Annual Reports for 1948–49

THE administration reports of the director of the National Museums in Ceylon for 1948 and 1949 (Report for 1948, pp 17+2 plates, Report for 1949, pp 26+1 plate, Colombo Government Publications Bureau, 1949–50, 55 cents each) are issued at the same time and bear ample witness to the progressive and stimulating outlook of the director, Mr P E P Deraniyagala The usual methods of conservation of museum objects have been maintained throughout the period, and it is interesting to note that collections of live animals have been commenced at each of the provincial museums in Ceylon In common with other national museums, those of Ceylon are now responsible for various collecting expeditions, notably to India and Africa.

### Leeds City Museums: Annual Report for 1949–50

THE annual report of the Leeds City Museums for 1949–50 (pp 8, Leeds City Museum, 1950) records extensive new casing and reorganization in the main exhibition gallery The large mammals—of undoubted interest but restricted purpose—have been reduced in numbers, and with new cases and upright partitions the appearance of the gallery has been completely altered At one end is a brief introduction to animal life, and such subjects as life on land, in the water and in the air, the pattern of life and life histories are dealt with Other bays provide a visual picture of the four chief types of country seen in Yorkshire At the other end of the gallery the history of man is portrayed, local objects being used whenever possible A systematic series, of both invertebrates and vertebrates, has been arranged on a balcony At Kirkstall Abbey House the exhibition cases have been removed so as to reveal the full beauty of the medieval architecture in the vaulted room A display of armour and weapons has been mounted around the walls Temporary exhibitions of varied character, a school loan service, lunch-hour musical recitals, film shows, winter lectures and weather recording are among the activities of this progressive museum

### Lectures for Junior Science Societies and Clubs

A REPORT on "Science Clubs for Young People" has recently been prepared for the United Nations Educational, Scientific and Cultural Organization This report has been approved by the Council of the British Association for the Advancement of Science, which wishes to help and encourage existing science clubs, to assist new clubs which may be formed in response to a real demand and to promote co-operation between kindred groups The Association of School Natural History Societies already exists to help school and other junior scientific societies concerned with the biological sciences, and many such societies have sought its advice regarding suggestions for suitable speakers The British Association is prepared to supplement this existing service by suggesting speakers on subjects which are covered by its sections, that is (A) physics and mathematics, (B) chemistry, (C) geology, (D) zoology, (E) geography, (F) economics, (G) engineering, (H) anthropology and archæology, (I) physiology, (J) psychology, (K) botany, (L) education, and (M) agriculture Requests for such assistance should be addressed to the secretary of the British Association Burlington House, London, W 1, with as much advance notice as possible and indicating the subject on which a lecture is desired, the proposed time and place of its delivery, and whether it will be possible to meet the lecturer's out-of-pocket expenses

### "Phosphorylation and Absorption of Sugars in the Rat"

WE regret that, in the communication under this title by Miss M P Hele published in *Nature* of November 4, p 786, the description of the two graphs was omitted It should read as follows Effect of sugar concentration upon the rate of sugar phosphorylation Adenosinetriphosphate concentration 0 033 *M*

□, Galactose (average of 4 rats), ○, glucose (average of 8 rats), ●, fructose (average of 8 rats), ⊙, mannose (average of 5 rats), ×, xylose (average of 5 rats)

### Announcements

THE Harrison Memorial Prize for 1950 of the Chemical Society has been awarded to Dr Hugh Christopher Longuet-Higgins, lecturer in theoretical chemistry in the University of Manchester. This Prize was founded in 1922 in memory of Colonel Edward Frank Harrison, deputy controller of the Chemical Warfare Department during the First World War It is awarded to the British chemist, less than thirty years of age, who, in the opinion of the selection committee, has during the previous five years conducted the most meritorious and promising original investigations in chemistry

A CHRISTMAS lecture for older schoolchildren, entitled "The Electric Current, its Action and Nature", will be given by Dr W Wilson, manager of the Development Laboratory, General Electric Co, Ltd, Birmingham, at 3 p m on January 2, 1951, and again on January 3, in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2 Applications for admission should be sent to the Secretary of the Institution at the above address

SCOTTISH Agricultural Industries, Ltd, is setting up in the Edinburgh area a new Central Research Department which will, initially, be engaged mainly on research into problems of phosphatic and other fertilizer manufacture Dr Bernard Raistrick, at present assistant director of research with Albright and Wilson, Ltd, has been appointed research manager of this new Department

# BIOLOGICAL ACTION OF 'MUSTARD GAS' COMPOUNDS

## Mutagenic Activity of beta-Chloroalkyl Amines and Sulphides

IN attacking the problem of the mechanism of biological action of mustard gases, particularly their mutagenic and anti-carcinogenic effects, we have determined the activity of a series of beta-chloroethyl amines and sulphides containing only one reactive grouping A study of such types of molecules (I and II) is of particular interest in exploring the relation of chemical structure to biological activity. Some monochloroethyl sulphides show the vesicant property of mustard gases On the other hand, there are indications that mutagenic and anti-carcinogenic activities may be confined to molecules containing two or more reactive groupings[1-3]

$RSCH_2CH_2Cl$ (I) $R_2NCH_2CH_2Cl$ (II)

In the present study, the mutagenic activity[4] of the compounds has been tested using the technique described by Dickey *et al* [5] In this method nutritionally deficient mutant strains of *Neurospora crassa* are used The activity of a substance in causing reversions to the non-deficient state is measured Results of typical experiments are given in the accompanying table The 'induced mutation rate'[5] is the number of mutants produced divided by the total number of spores treated. In all cases, the tests were carried out in 10 per cent aqueous acetone, 0 25 *M* in sodium chloride, and 0 1 *M* in borate (*p*H 8). The treatments were made at 25° for 30 min , using three to four million spores per millilitre

MUTAGENIC ACTIVITY OF MUSTARD-TYPE COMPOUNDS

| Compound | Conc (*M*) | Induced mutation-rate ($\times 10^7$) | |
|---|---|---|---|
| | | Adenine-less mutant (70007–38701) | Inositol-less mutant (70007–37401) |
| None | — | (0 3*) | (0 0) |
| $ClCH_2CH_2SCH_2CH_2Cl$ | 0 0002 | 4 | — |
| " | 0 0001 | 3 | 1 |
| $n\text{-}C_4H_9SCH_2CH_2Cl$ | 0 0002 | 64 | 1 |
| " | 0 0001 | 11 | — |
| $C_6H_5CH_2SCH_2CH_2Cl$ | 0 0002 | 12 | — |
| $C_6H_5SCH_2CH_2Cl$ | 0 0002 | 2 | — |
| $N(CH_2CH_2Cl)_3$ | 0 0002 | 2 | — |
| $CH_3N(CH_2CH_2Cl)_2$ | 0 001 | 4 | 2 |
| " | 0 0005 | 2 | 2 |
| $(CH_3CH_2)_2NCH_2CH_2Cl$ | 0 006 | 13 | 0 5 |

* Average of all control experiments In no case was the spontaneous mutation-rate greater than 1 0 × $10^{-7}$

It will be noted that the response of the two mutant strains is distinctly different For the adenine-less, colonial double mutant (70007–38701), the monofunctional sulphur mustards were even more active than mustard gas itself This was true also of the monofunctional nitrogen mustards when the compounds were compared at the concentration giving maximum activity Toward the inositol-less, colonial double mutant (70007–37401), on the other hand, both the monofunctional and polyfunctional nitrogen and sulphur mustards showed slight activity

The finding that these monofunctional mustard-type molecules have pronounced mutagenic activity is of importance to the study of the mechanism of production of mutations. It provides a clue to the relation of structure to mutagenic activity, and also a simpler molecular type for chemical studies[6]

One of us (C M S ) is greatly indebted to Dr. G. W. Beadle and his staff for the mutant stocks and for the opportunity of carrying out some of these experiments in their laboratories The study was supported in part by the American Cancer Society, in part by the Rockefeller Foundation, and in part by funds provided for biological and medical research by the State of Washington Initiative Measure No 171.

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AUGUSTA MYLROIE

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Department of Chemistry,
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Pullman.

June 7

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[2] Burchenal, J H , Lester, R A , Riley, J B , and Rhoads, C P., *Cancer*, 1, 399 (1948)

[3] Goldacre, R J , Loveless, A , and Ross, W C J , *Nature*, 163, 667 (1949)

[4] cf Kölmark, G , and Westergaard, M , *Hereditas*, 35, 490 (1949).

[5] Dickey, F H , Cleland, G H , and Lotz, C , *Proc U S Nat Acad. Sci* , 35, 581 (1949)

[6] cf du Vigneaud, V , Stevens, C M , McDuffie, H F , jun , Wood, J L , and McKennis, H , jun , *J Amer Chem Soc* , **70**, 1620 (1948)

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## Production of Mutations by Monochloro-'Mustards'

IN 1942 it was noticed[1] that 'mustards' with one reactive chlorine atom are less toxic than those with two, to a degree which cannot be accounted for by the difference in chlorine content More recently, workers at the Chester Beatty Institute in London, in the course of an extensive comparative study of nitrogen mustards and related compounds, have made the same observations for the tumour-inhibiting and cytotoxic activities of these substances[2-4]. They conclude that the presence of 2-chloroethyl chains is a necessary condition for biological activity in this class of chemicals, and they suggest that chromosome breakage and mutation arise through cross-linkage between protein fibres of the chromosome It seemed desirable to test this hypothesis by mutation experiments with some monochloro-'mustards'.

The experiments were carried out on *Drosophila melanogaster*, using a standard technique for the scoring of induced sex-linked lethals Two substances were used (1) the first hydrolysis product of mustard gas, $ClCH_2\,CH_2\,S\,CH_2\,CH_2OH$, referred to as 'semi-*H*', and (2) 'butyl-*H*', $CH_3\,CH_2\,CH_2\,CH_2\,S\,CH_2\,CH_2Cl$. Both these substances had already been used in experiments by Kinsey and Grant[5] on yeast cells, and had been found to resemble mustard gas in the production of an irreversible growth inhibition, not paralleled by the effect on carbohydrate metabolism. Moreover, in experiments by Stevens[6], butyl-*H* had produced reverse mutations in *Neurospora* We have to thank Mr J L Everett, of the Chester Beatty Institute, for preparing the semi-*H*, Dr. M. Bird of the same Institute for exposing the flies to it, and Prof. C. M. Stevens, of Pullman, Washington, for sending us a sample of butyl-*H*. Semi-*H*, dissolved in arachis oil in a 5 per cent solution, was applied as aerosol, butyl-*H* as vapour in an air-stream which passed through the container with the flies The times of exposure chosen were long enough to kill a proportion of the males within a few days after treatment No controls were taken, but the stock to which the treated males belonged (*OrK*) has been in constant use for mutation work in this laboratory for many years, and consistently yields a frequency of about 0 3 per cent sex-linked lethals per generation.

*Semi-H* Two exposures, of 45 and 50 min. respectively, gave a combined frequency of 22 lethals in 1,939 tested *X*-chromosomes This result, 1 1 per cent lethals, is well outside the range of spontaneous mutability of the stock employed, but as Mr. Everett did not feel sure that his preparation had been free of traces of mustard gas, new experiments were undertaken with butyl-*H*

*Butyl-H* A preliminary experiment indicated an increase in mutation-rate in later broods from exposed males Therefore the males for the two main experiments were mated to a succession of fresh virgin females every third day, and mutation-rates were recorded separately for each brood. Successive broods represent successively younger germ cells at the time of exposure. The pooled data, subdivided into broods, are presented in the accompanying table.

FREQUENCY OF SEX-LINKED LETHALS IN SUCCESSIVE BROODS FROM MALES TREATED WITH BUTYL-*H* ($CH_3\ CH_2\ CH_2\ CH_2\ S\ CH_2\ CH_2Cl$)

| Brood | Days after treatment | No of chromosomes tested | No of lethals | Per cent of lethals | No of semi-lethals | Per cent of lethals plus semi-lethals |
|---|---|---|---|---|---|---|
| 1 and 2 | 1–6 | 1610 | 33 | 2 1 | 11 | 2 7 |
| 3 | 6–9 | 911 | 30 | 3 3 | 9 | 4 3 |
| 4 and 5 | 9–15 | 1909 | 21 | 1 1 | 3 | 1 3 |

The data prove the mutagenic power of butyl-*H* The course of mutation frequency with time after treatment is the same as for mustard gas[7,8] with a peak in the third brood, followed by a decline Another similarity with mustard gas consists in the fact that, of 20 sufficiently analysed semi-lethals, 10 (= 50 per cent) turned out to be gonadic mosaics for a lethal This suggests a delayed mutagenic effect of butyl-*H*[9]

It thus appears that the possession of two biologically active groups and the capacity to form cross-linkages between protein chains are not indispensable properties of mutagenic molecules It may still be argued that they are required for the production of chromosome breakage as opposed to gene mutation. This, in fact, has been suggested by McElroy and de la Haba[10] in interpretation of their finding that hydrostatic pressure during or shortly after exposure of *Neurospora* conidia to nitrogen mustard reduces the frequency of induced morphological mutants Since, however, the authors believe that most of these mutants are connected with gross structural changes of the chromosomes, it seems that their result could also be explained as an effect of increased pressure not on the process of chromosome breakage, but on the subsequent process of reunion which, under conditions restricting movement of broken ends, may lead to restitution rather than re-arrangement. Moreover, chromosome breakage has been produced by a great variety of substances, including many which can scarcely be suspected of cross-linking power (for example, urethane, formaldehyde, pyrogallol) The intended analysis of the lethals which have been produced by butyl-*H* will show whether any of them are connected with re-arrangements, the fact that two of them have a dominant notch effect makes this likely

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H MOSER

Institute of Animal Genetics,
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Sept 19.

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[1] Holiday and Ogston, 1942, quoted by Ogston, A G, Sympos Biochem Soc, 2, 2 (1948)

[2] Haddow, A, Kon, G A R, and Ross, W J C, *Nature*, 162, 824 (1948)

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[10] McElroy, W, and de la Haba, G, *Science*, 110, 640 (1949)

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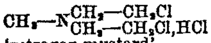
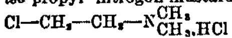
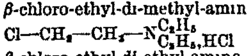
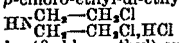
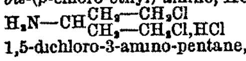
## Mutagenic Activity of some 'Mustard Gas' Compounds

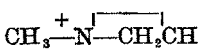
THE problem of the chemical mechanism involved in the mutagenic activity of the 'mustard gases' has been approached by some experiments with mono-chloro- and dichloro-'nitrogen mustards' which have been carried out in our Laboratories The mutagenic activity was tested by means of the *Neurospora* back-mutation test[1] with an adenineless colonial double mutant used as a test strain The data are grouped in the accompanying table

| Compound | 1/50 mol |  |  | 1/100 mol |  |  | 1/200 mol |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  | p c survived | mutations | mut per $10^6$ survived | p c survived | mutations | mut per $10^6$ survived | p c survived | mutations | mut per $10^6$ survived |
| 1.  $CH_3—N\begin{smallmatrix}CH_2—CH_2Cl\\CH_2—CH_2Cl,HCl\end{smallmatrix}$<br>'nitrogen mustard' | 0 | 0 | 0 | <0 01 | 1 | 400 | 1 | 13 | 22 |
| 2 $C_3H_7—N\begin{smallmatrix}CH_2—CH_2Cl\\CH_2—CH_2Cl,HCl\end{smallmatrix}$<br>*iso*-propyl 'nitrogen mustard' | 0 | 0 | 0 | 15 | 14 | 5 | 25 | 14 | 3 |
| 3.  $Cl—CH_2—CH_2—N\begin{smallmatrix}CH_3\\CH_3,HCl\end{smallmatrix}$<br>$\beta$-chloro-ethyl-di-methyl-amine,HCl | 0 | 0 | 0 | 11 | 12 | 17 | 15 | 9 | 10 |
| 4.  $Cl—CH_2—CH_2—N\begin{smallmatrix}C_2H_5\\C_2H_5,HCl\end{smallmatrix}$<br>$\beta$-chloro-ethyl-di-ethyl-amine, HCl | 8 | 63 | 11 | 12 | 25 | 2 | 100 | 0 | 0 |
| 5.  $HN\begin{smallmatrix}CH_2—CH_2Cl\\CH_2—CH_2Cl,HCl\end{smallmatrix}$<br>*bis*-($\beta$-chloro-ethyl)-amine, HCl | 100 | 0 | 0 | — | — | — | — | — | — |
| 6  $H_2N—CH\begin{smallmatrix}CH_2—CH_2Cl\\CH_2—CH_2Cl,HCl\end{smallmatrix}$<br>1,5-dichloro-3-amino-pentane, HCl | 100 | 0 | 0 | — | — | — | — | — | — |

Controls less than 0 03 mutations per $10^6$ spores

Compound No 1 is the normal 'nitrogen mustard'. When for the methyl group is substituted an *iso*propyl group (No. 2) both the mutagenic activity and the toxic effect decrease. The two next compounds are both 'monochloro mustards' No 3 has already been found to be mutagenic by Stevens[2] The mutagenic effect of Nos 3 and 4, together with the data of Stevens[2] and of Auerbach and Moser[3], shows that the effect of the 'mustard gas' molecule does not depend on its ability to form cross-linkages with the protein, as assumed by several authors[4,5], since this reaction assumes the existence of two active chlorine atoms This is further supported by the negative results obtained from compounds 5 and 6, both of which should be able to form cross-linkages

None of these compounds is, however, able to form iminium ions similar to the ion,



which, as already pointed out by Gilman and Philips[6], seems to be the first step in the reaction of the 'nitrogen mustard' molecule Hence we conclude that it is the ability of the molecule to form the highly reactive iminium ion which is the prerequisite for the biological activity of the 'mustard gas', and that the level of activity determines the level of mutagenicity as well as toxicity, since the larger and therefore less reactive molecules of compounds 2 and 4 are less active than compounds 1 and 3 respectively As a working hypothesis it still seems most likely that the mutations are induced by the release of energy from the reactions of these very reactive compounds

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Sept 19

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[2] Stevens, C M , and Mylroie, A (see previous letter).

[3] Auerbach, C , and Moser, H (see preceding letter)

[4] Goldacre, R J , Loveless, A , and Ross, W J C , *Nature*, 163, 667 (1949)

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# FRESHWATER BIOLOGICAL ASSOCIATION

## OPENING OF WINDERMERE LABORATORY

ON September 23 the Countess of Albemarle, chairman of the Development Commission, formally opened the new laboratory of the Freshwater Biological Association at the Ferry House, Far Sawrey, Ambleside, Westmorland, on the western shore of Windermere The Ferry House stands on a small promontory projecting from the western shore of Windermere mid-way between the ends of the Lake The site, of some 2½ acres, is almost surrounded by water A road past the building to the tip of the promontory leads to a cable-ferry to the Bowness shore 560 yards away. The main building was built of local stone in 1880 as a hotel of some forty bedrooms Its rooms are of convenient sizes and well provided with windows. On the ground floor are the library, a common room, a large laboratory for the use of classes and visiting scientific workers, a dining-room and domestic offices; a small electrical workshop, and laboratories used by assistants and for the supply of biological material to universities and schools The first floor contains administrative offices and fourteen rooms fitted as laboratories, mostly of a size suitable for one person but providing bench space for seventeen or eighteen scientific workers altogether One of these is fitted as a chemical laboratory, and there are also two dark-rooms and a small store-room The top floor provides living quarters for some members of the staff and also for visitors who come to work in the laboratory A semi-basement, which opens at ground-level on one side of the building, contains a room into which samples, fish, and collections of all kinds can be brought from boat or car for sorting, cleaning or washing There also are workshops, stores, a room for algal cultures and one for aquaria. On the other side of the road is a garage and stable block, which provides further storage space and several small rooms on an upper floor There is at present no boathouse, but it is hoped to build one on the shore of a sheltered bay adjacent to the garages Besides smaller boats in which outboard motors can be used, the Association has a 36-ft motor launch with a roomy cabin, from which most of the work on Windermere is done Row-boats are also kept on certain other lakes, and a smaller craft which can be towed in a trailer behind the large shooting-brake makes it possible to obtain samples from lakes on which there are no boats.

The opening ceremony was attended by some three hundred people, including representatives of the Royal Society, the Ministry of Agriculture and Fisheries, and several of the universities The president of the Freshwater Biological Association, Mr Reginald Beddington, in an introductory address, recalled that the foundation of the Association twenty-one years before, in June 1929, resulted from a joint discussion held by Sections D (Zoology) and K (Botany) of the British Association for the Advancement of Science at the Glasgow meeting of 1928 He also referred to the fact that it was on September 23, 1931, that the Association's scientific staff began work at Wray Castle

Prof F E Fritsch, chairman of the Council of the Association, gave an account of the objects for which the Association was founded and of the work carried on After referring to the award to the Association of the Einar Naumann Medal at the International Limnological Congress in Zurich in 1948, Prof Fritsch said "It is comparatively simple to state our aims in establishing the laboratory, namely, to study the conditions of life of the organisms inhabiting fresh waters and especially those not seriously affected by human interference We wish to ascertain the composition and distribution of the fauna and flora inhabiting such waters and the factors beneficial to the life within them, so as to provide a better basis for the assessment of the effects of pollution and the study of other problems encountered in the utilization of water and the maintenance of populations of fish. These projects are far-reaching and, as usual in research of any kind, every fresh discovery has opened up new avenues for investigation and widened the horizon to be embraced "

Prof Fritsch referred to the work of Dr T T. Macan in relating the larvæ of insects to their adult stages, of Dr J W G Lund on the planktonic plants, and of Dr H M Canter on the Chytrid fungi parasitic on the plankton algæ He said that one of the main concerns of the Association has been to investigate the conditions determining the productivity of a water, a laborious proceeding since it entails frequent counting of the numbers of certain species together with regular chemical analyses of the water and records of light, temperature and other environmental factors In this field Dr C H Mortimer and Mr F J H Mackereth have added to the knowledge of the physical and chemical properties of lakes and have introduced improved methods of investigation The study of the seasonal changes in the animal and plant life of a lake has revealed their cyclical nature and the importance of the surface layers of the bottom mud as the main site of the processes of decay which result from bacterial action The Council has recently taken steps to provide for more intensive work on the role of bacteria in fresh-waters In the investigation of the bottom sediments, the Association is much indebted to Mr B M Jenkin for the design and construction of special apparatus for lifting entire cores to the surface The study of such cores by Mrs T G Tutin has shown that they are by no means only of geological interest, but may provide a historical background to the studies on productivity The Council therefore hopes to resume these investigations which have been temporarily allowed to lapse

Prof Fritsch referred next to the work of Mr K R Allen, Dr W E Frost and Mr E D Le Cren, all of whom have contributed to the knowledge of the biology of various species of fish A large-scale ecological experiment begun by Dr E. B Worthington, in the course of which about 95 tons of perch and many large pike have been removed from Windermere since 1941, is still in progress, and the effects of this disturbance of the balance of the fish population will only gradually become apparent Among the significant changes already observed is an increase in the breeding stock of char, which were seen spawning in the River Brathay in 1948 for the first time for forty years

Hitherto the Association's work on fish has been observational rather than experimental, and concerned more with static than with flowing waters The acquisition of a lease of Wraymires hatchery and fish-ponds, 2½ miles from the Ferry House, provides opportunities for ecological, physiological and genetical experiments on the problems connected with the growth of fish Moreover, the Council now feels that sufficient progress has been made with fundamental researches to approach with confidence the more difficult problems of rivers It is therefore hoped to establish a second smaller laboratory on one of the southern rivers, in order to extend the scope of the research, especially on certain fish, and to make possible the comparison between conditions in the streams of the Lake District and those in a southern chalk stream

Mr Beddington then spoke of the help and support the Association has received from the Development Commissioners and from their secretary, Mr E H E Havelock, and called upon the Countess of Albemarle to declare the new laboratory open Lady Albemarle paid tribute, for their work on the Association's behalf, to Mr. Beddington, Prof Fritsch, Prof. W. H. Pearsall, Mr J T Saunders, the second Lord Rothschild, who was the first president, and the late Sir Albert Atkey, who was honorary treasurer for many years The Association also owes much to its staff, especially Mr P Ullyott and Mr R S A Beauchamp who began the work under Prof Pearsall's guidance, Dr E B Worthington, the first director, and not least the present director, Mr H C Gilson, on whom has fallen the task of seeing that the Ferry House should be ready that day.

The Development Act of 1909, continued Lady Albemarle, made no reference to freshwater biology, nor indeed to research in connexion with fisheries, though research was specifically mentioned in relation to agriculture From the first the Commissioners worked to ensure that the resources of science should be brought to bear on the practical problems of fisheries, bearing in mind that they were instructed to promote economic development Since the Commissioners were also concerned with the general welfare of the countryside, they did not limit themselves to the interests of commercial net fisheries Nevertheless, they had to consider aid for freshwater fishery research from the economic point of view, and the amount of money which could be made available was therefore limited and had to be related to other claims on the Development Fund

To advise on the principles which should guide the spending of this money, the Commissioners in 1919 appointed an Advisory Committee on Fishery Research The chairman was Sir William Hardy, the other scientific members being William Bateson, W M Bayliss, G C Bourne, H. H Dale, Walter Garstang, John Graham Kerr, E W. MacBride and R E Scharff, two laymen interested in the immediate problems of deep-sea and inshore fishermen, G C L. Howell and Harold Wright, were also members This committee's report contained the following passages, which although they related to sea fisheries were also relevant to those in fresh water " nothing less than a complete knowledge of the sea and the life in it, and especially the interdependence between fish problems and *all* the conditions of fish life, will suffice to form a rational basis for fishery development . . Another principle governing the organisation of research is that opportunity must be given for the appearance and growth of new ideas It is impossible at the outset to say what ideas will lead to results of economic importance . The real problem, as the Committee conceive it, is not to distinguish whether this or that class of research, free or economic, pure or applied, is most likely to lead to immediate practical results, but to detect and secure that organisation which shall best promote the development of the fisheries by the increase of the knowledge of all marine life "

For administrative purposes the Advisory Committee adopts a distinction between 'directed' research financed through government departments and 'free' research which is supported in independent laboratories There is general scientific supervision of programmes and of the quality of the work by the Advisory Committee, but the Commissioners have never attempted the impossible task of determining whether or not a particular part of a programme is likely to have economic value It is essential that the closest relations should be developed between, on one hand, the growing staffs of the Fisheries Departments and of the Water Pollution Research Board of the Department of Scientific and Industrial Research and, on the other, those whose future base would be the Ferry House The first necessity is to identify the major practical problems, so that those whose task is to build up basic knowledge of all the aspects of life in river, stream and lake can bear those problems in mind, then their fundamental research will be, in

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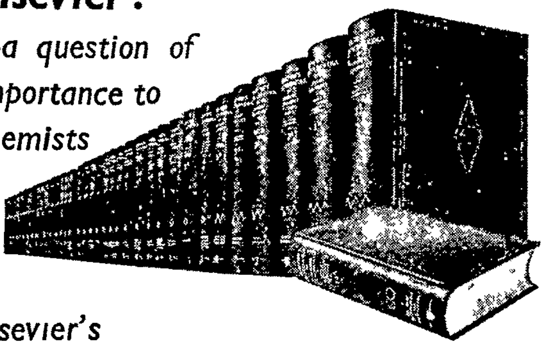

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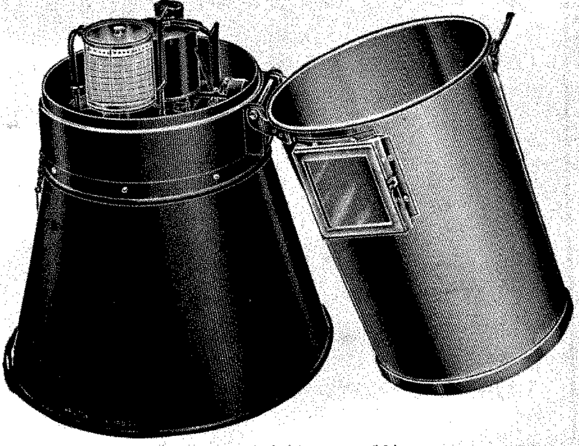

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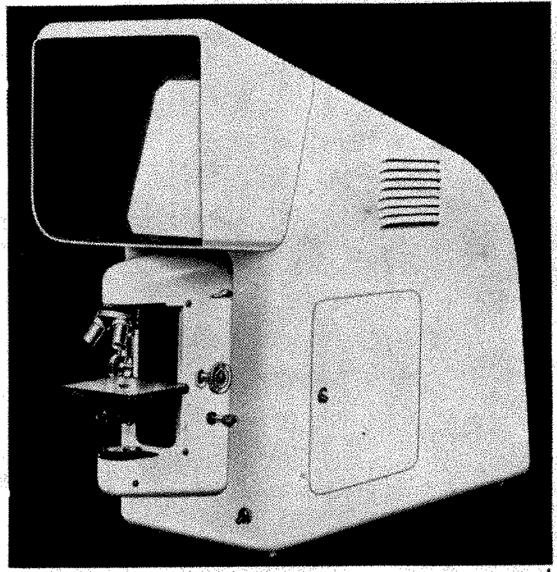

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¶ Enzymology has become the central province of biochemistry and the biological sciences Research in this field has progressed to such an extent that a comprehensive survey of findings has appeared as increasingly imperative This new work presents systematically the accumulated knowledge in the various phases of enzymology and is designed to serve those already working in the field and those preparing to enter it

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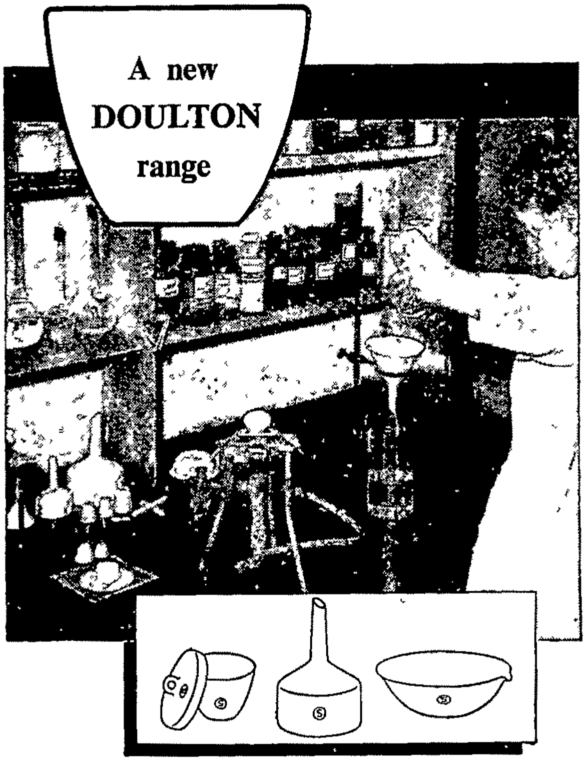

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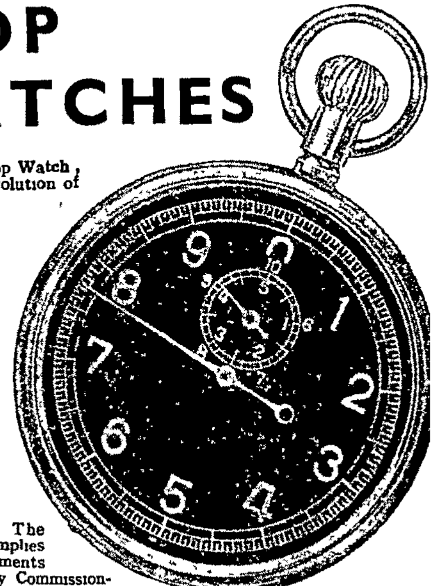

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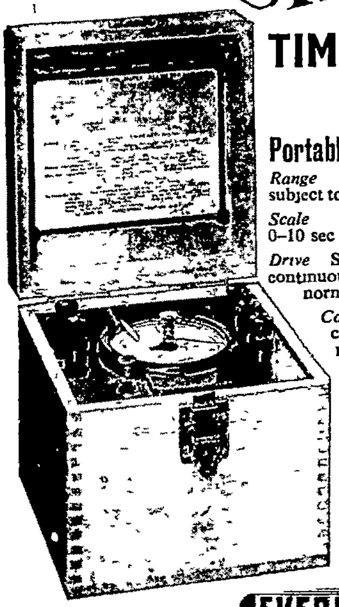

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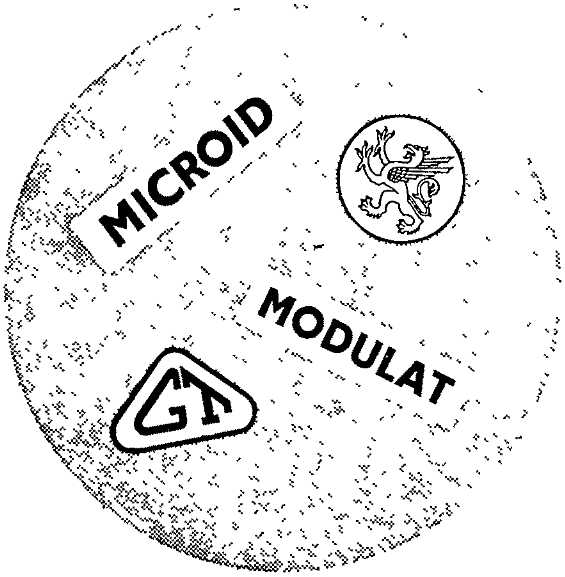

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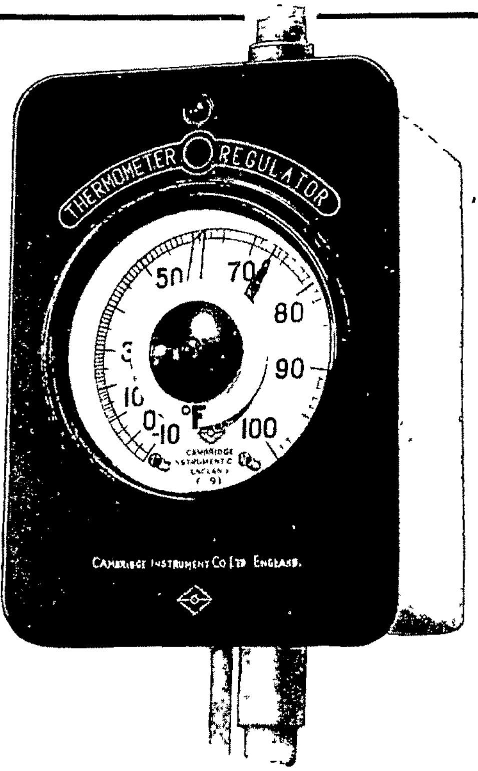

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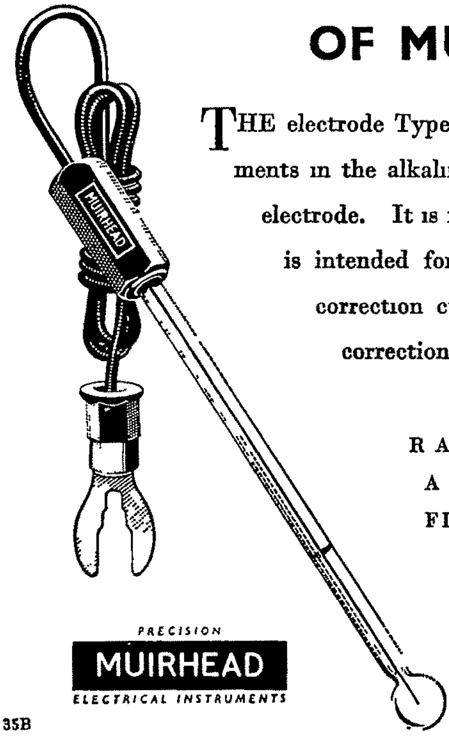

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the words of Sir Edward Appleton, "objective fundamental research" The choice of subjects for 'free' research is difficult and, when freedom is given, the temptation to pursue fascinating by-paths merely for the sake of exploration must be resisted The Commissioners hope that, by choosing staffs wisely and giving them the accommodation they need, it will be possible to build sound foundations

In considering priorities after the Second World War in the light of the principles laid down by the original Advisory Committee, the Commissioners have been advised by a special committee of which Sir John Graham Kerr is chairman This committee discusses with representatives of the Association a memorandum on post-war development prepared by the Council Its recommendations for the strengthening of both staff and equipment, especially in the fields of algology and bacteriology, have now been implemented to a considerable extent For accommodation the Association has been exceptionally fortunate in finding the Ferry House, for it would otherwise have been necessary to remain for some five years at Wray Castle and then acquire land on which to build afresh

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# MANCHESTER COLLEGE OF TECHNOLOGY

## EXTENSION OF THE DEPARTMENT OF MECHANICAL ENGINEERING

AFTER numerous recent discussions of plans for technical education at the higher levels, it may be refreshing to consider the way in which older provision has been developed in an endeavour to meet modern requirements One such opportunity has been provided by the formal opening by Mr Louis Mather on December 7 of the first part of the extension to the Manchester Municipal College of Technology, namely, that devoted to mechanical engineering.

The College, which was founded as a Mechanics Institute in 1824, has a double role, first as the major technical college in a wide regional scheme and dealing with subjects at an advanced level (higher national certificates, special and refresher courses, etc ), and secondly as incorporating the Faculty of Technology of the University of Manchester, with which it was integrated in 1903, and working for the Bachelor's, Master's and Doctor's degrees The happy blending of these two functions, with marked advantages to both sides, is a major feature of the work of the College, and provides opportunities for developments, particularly in connexion with part-time activities

Though the building completed in 1903 stands as a majestic monument to the courage and wisdom of its founders, provision was made for its growth, and the extension under construction, which will double the original size, forms an integral part of the whole The section now being opened contains one very large single-storey laboratory, several smaller laboratories and stores, offices for members of the staff, and two drawing offices Alternative accommodation is also provided for other departments, and will enable the Department of Mechanical Engineering to extend considerably its laboratory facilities in the older building Though schemes developed since the commencement of construction, delayed by the War, have necessitated changes in the purposes to be served by the various rooms, these have been skilfully adapted, and the general impression is one of fitness and great dignity The full provision of offices for the staff and of a departmental committee room will not be available for a few months, but the facilities for quiet study and undisturbed consultation, so often overlooked, have received appropriate attention It will be a little time yet before the full adjustments in the older building are completed, but there is no doubt that the final result will be very good

Though the arrangements made in 1903 were considered very lavish, it is interesting to note that five laboratories and access to the College power-house were considered adequate to cover the various branches of mechanical engineering exclusive of craft-work, which is now dealt with elsewhere In contrast, the later developments in engineering science and technology, and the refinements of modern methods, now call for more than four times this provision For example, the measurement of the fundamental engineering quantities, such as size and form, temperature and heat, quantity, pressure and velocity of flow, which formerly occupied only small sections of general laboratories. now require separate provision and call for a degree of specialized knowledge and skill which, combined with work of a more traditional nature, make the selection and training of staff a far more formidable task than in earlier days Nor can the requirements of modern industry in respect to such measurements be considered as essentially of a lower order than those for research There are no separate research laboratories It is a deliberate policy throughout the Department to bring teaching and research into close relationship so that the student becomes conscious of the refinements which can be made to the relatively simple apparatus which he himself uses, of the skill required in their handling, and of the concentration and care needed in planning, carrying out and completing an experimental investigation Through the help given in the laboratories to industrialists seeking the advice and assistance of members of the staff, the student becomes aware also of the close relationship of his own task to the needs of the profession he is seeking to follow—a matter which too easily becomes obscured, to his considerable discouragement

The equipment of the Department can be classed roughly under headings (1) normal teaching equipment, (2) equipment for precise basic measurement, (3) special-purpose plant for specific investigations , but such a classification is far from satisfactory For example, the precision measuring equipment may well be required to illustrate the logical development of the apparatus actually handled by the students, as well as being fundamental to research, while the systematic planning of research ensures that, through the medium of the equipment required, it will contribute to the work of the Department as a whole It is interesting that research projects, though very frequently arising from discussions with the representatives of industry and receiving much help from them, are entirely under the control of the head of the Department, and that, in fact, suggestions for work which might be considered as routine or developmental are scarcely ever made

The contribution of industry to the equipping of the Department, whether for teaching or research, is remarkable, both for its liberality and for the co-operative spirit in which it is made It may take the form of raw material, a complete major unit of plant, or of a large number of items which together form a unified whole A completely air-conditioned and automatically controlled wind tunnel for heat transfer tests is an example of the latter, sixteen firms having worked together to produce a unique plant of great value

In addition to generous help from the local education authority, and from the University Grants Committee, the College has profited very greatly from the scheme for the acquisition of surplus government equipment in the development of which it played a leading part, and from loans from government departments

In a Department which has been almost entirely equipped or re-equipped on a lavish scale within a few years, only a few sections can here receive special mention The many problems relating to heat claim six laboratories, including extensive provision for the study of heat generation and transmission involving the use of a number of wind tunnels, of refrigeration and of instrumentation The large new laboratory is devoted to the detailed examination of the various machining processes, to the structural and functional design of machine tools, and to advanced welding methods and the design of welded structures The laboratory for the examination of the strength of materials contains much excellent equipment and has ample provision for the study of fatigue, and a very wide range of strain-measuring devices A new laboratory for the study of problems in relation to hydraulic power transmission is being equipped to supplement the more normal work of the Mechanics of Fluids Laboratory The excellence and range of equipment in the Engineering Metrology Laboratories place them in a unique position to aid in the development of the teaching of the subject up to the highest levels and to serve precise researches in many branches of engineering Though less spectacular, the work of the Department on the close study of teaching methods in the laboratory and the teaching of machine design is of considerable interest

The Department of Mechanical Engineering is very happily supported in its work by associated Departments of Electrical Engineering, Metallurgy, Physics, Chemistry and Mathematics, to which it contributes in its turn

The College can indeed be congratulated on having achieved a unity of purpose by a process involving adaptability and constructive compromise, and for the part which it is playing in the development of the study and teaching of technology in Great Britain

# COMMITTEE ON INDUSTRIAL PRODUCTIVITY

## REPORT FOR 1949

THE second report of the Committee on Industrial Productivity*, which covers the activities of the Committee during 1949, is also the final report, for in it the Committee reaches the conclusion that no further purpose would be served by its continuance, as the tasks hitherto entrusted to it can in future be better performed by other existing bodies In a written statement to Parliament on July 24 the Lord President of the Council announced that the Government had accepted the Committee's own recommendation for its discharge, the Lord President said further that, since the time when the Committee and its panels were set up as a short-term measure to bridge the gap between the winning and application of knowledge in both the natural and the social sciences, the importance of increasing industrial productivity has, become generally accepted and productivity is increasing at a most encouraging pace

The Committee in its report refers to the work of the Anglo-American Council on Productivity which has already sent twenty-four productivity teams, representative of the management-, technical- and workshop-levels in selected sectors of British industry, to visit the corresponding sectors of industry in the United States, and to the action taken by more than twenty trade associations, encouraged by the Engineering Advisory Council of the Ministry of Supply, to work out mutual aid schemes or increase efficiency and reduce costs The General Council of the Trades Union Congress has decided to establish a productivity department and has asked the British Institute of Management, which is steadily increasing its activities, to prepare a handbook on productivity techniques for workshop representatives, etc

Besides work on standardization and simplification in industry and the establishment of the National Research Development Corporation in June 1949, good progress has been made in the development of joint consultation and works information in industry, while the Technical Assistance Scheme of the Economic Co-operation Administration has made possible visits to the United States by a number of specialists and technicians from Government departments and research associations to examine particular problems in the United States from the point of view of increasing production and efficiency in Great Britain Arrangements can also be made for teams of experts from a number of countries to go to the United States to study, for the benefit of European industry as a whole, particular advances in American technology, and the United Kingdom has already participated in several such projects

Available figures indicate that productivity has been steadily increasing during the past two years, and the Committee on Industrial Productivity regards it as reasonable to assume that the increased production is due chiefly to an increased annual output per worker It emphasizes that, while the part played by science and technology in promoting productivity is clear and well recognized, but subject for achievement to such conditions as an ample supply of power and of capital for improvement, it is doubtful whether the importance of the human side of the problem is yet sufficiently appreciated Technical improvements cannot achieve their full effect if the necessary human relations are lacking The Committee believes that scientific investigation can help the promotion of good human relations, and that it is necessary to develop the social sciences side by side with the physical sciences, the approach to the human aspects of this problem must not be too narrow, but should be based on a study of all relevant parts of social environment Furthermore, the Committee is of the opinion that it is not always enough, in considering possible improvements in productivity, to examine human factors alone or in isolation, human and technological factors in industry tend to be intermingled or intimately related and to react so decisively on each other as to call for a joint consideration of the two aspects

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* Second Report of the Committee on Industrial Productivity (Cmd 7991 ) Pp 10 (London H M Stationery Office 1950 ) 4*d* net

The Panel on Human Factors in Industry has continued to sponsor the nine research projects mentioned in the first report of the Committee, and in addition has been concerned with the training of field-workers for research into social problems in industry, the effects of compulsory National Service on the training and attitude to work of young industrial workers, and arrangements for ensuring the effective dissemination of information acquired in the course of research into the human aspects of the production problem Reports on the research projects are expected to be ready in the latter half of this year, and the Committee thinks that their completion should be made the occasion for a full review of the Panel's work This review, the Committee recommends, should be carried out by the Medical Research Council, and the Government should then consider whether the scheme which that Council is working out with the Department of Scientific and Industrial Research for undertaking wider programmes of work in the field of human factors will adequately cover the national needs in this field

The statement on July 24 by the Lord President of the Council indicates that appropriate arrangements to this end are being made, and also that the Panel on Imports Substitution is being re-formed to deal with technical aspects of the development of natural resources, whether to save imports or not. The Committee's other recommendation that the work of the Panel on Technology could be adequately provided for by the appropriate production departments and by the Department of Scientific and Industrial Research calls for no specific action, but, as recommended by the Committee on Industrial Productivity, the Advisory Council on Scientific Policy has taken over, as a matter of long-term concern to science and industry, the responsibility for following up the work of the Panel on Technical Information Services (see *Nature*, August 26, p 323). Here, as generally, the main reason for the termination of the work of the Committee is that the keener and more general interest in the wide range of problems with which it has been concerned has diminished the value of its own contribution, and has made it more important for the main responsibility for studying these problems to be placed on more specialized bodies and on those in day-to-day touch with particular industries

# STOCHASTIC PROCESSES

THREE papers, which have already appeared in the *Journal of the Royal Statistical Society* (Series B (methodological), **11**, No 2) and which were read at a symposium on stochastic processes held on June 9 last year, have now been published together in one volume[*] While in no sense a complete exposition of this thriving field of research, they provide a lucid introduction to three different aspects of the theory, together with important original contributions

The first and longest paper, by J E Moyal, begins with a survey of statistical theories in theoretical physics, which is followed by a long and systematic account of stationary and additive random processes These two subjects are both well known to specialists in each ; but few are acquainted with both, and the main purpose of Moyal's paper is to demonstrate the very great importance which the theory of random processes is beginning to assume in many different branches of physics This is done in the third part of the paper, where the previously developed theory is applied to a variety of subjects such as the theory of quantum-mechanical wave packets, various aspects of the Brownian motion, the shot effect, the theory of noise and the theory of turbulence The paper concludes with an elaborate and original discussion of the differential equations of motion for the distribution functions of physical processes with applications to classical kinetic theory, the thermodynamics of non-uniform states and quantum theory

The second paper, by Prof M S. Bartlett, is concerned with evolutive processes which are either additive as in the problem of the random walk, or multiplicative as in more complicated situations Bartlett describes various special additive random processes such as those which occur in the theory of insurance risk and in industrial renewal theory, and unifies his discussion by basing it on Wald's fundamental identity in the theory of sequential analysis. This section concludes with a very pretty application of random walk theory to Kolmogoroff's theory of cumulative sample distribution functions

Multiplicative and other non-additive processes are described in the second part of Bartlett's paper. These have arisen in a variety of problems, the earliest being that of the probability of extinction of surnames, which was proposed by Galton Such processes also occur in physics and genetics Bartlett considers problems of a more complicated type concerned with what he calls "mixed" processes, and discusses, in some detail, the application of such a theory to the epidemiology of measles

D G Kendall's paper is mainly concerned with those multiplicative processes with a continuous time variable which are the natural probabilistic generalizations of the usual deterministic formulation of population growth, but he also gives a very interesting account of the history of the 'surname problem' mentioned above Kendall gives a lucid account of earlier work on stochastic population models and the related physical problems considered by Furry and Arley This is followed by an account of some further new contributions of his own. These deal with the problem of the estimation of parameters from an observed process, with the stochastic formulation of the 'problem of the two sexes' which has already been discussed deterministically by Karmel, and lastly with the stochastic fluctuations in the age distribution. Much remains to be done on these problems, especially the last

Not the least interesting part of this volume is the verbatim report of the discussion which followed the three papers This included a simple demonstration of the solution of the equations of the simple type of 'birth and death' process by N Arley, discussions of the application of stochastic processes to the mutation of bacteria by Coulson and Armitage, and further original contributions by Good, Prendiville and Le Couteur. The most impressive feature of the whole symposium is the very wide range of application of these theories, and it is clear that every person interested in the application of mathematics to other sciences should read this volume carefully.

P. A. Moran

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[*] Symposium on Stochastic Processes (Contributions by J E Moyal M S Bartlett and D G Kendall, and a verbatim report of the subsequent discussion) Pp 132 (London Royal Statistical Society, 1949) 12*s* 6*d* net

# LETTERS TO THE EDITORS

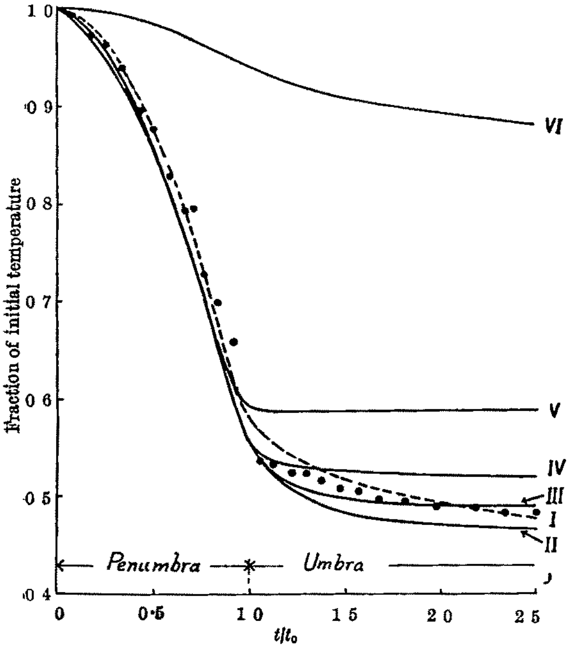
*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Nature of the Surface of the Moon

THE question of the nature and temperature of the lunar surface has recently acquired a new interest since microwave radar observations of the temperature have become possible. Twenty years ago Pettit, working in the infra-red, measured the fall of surface temperature during a lunar eclipse, and from this information Epstein[1] deduced that most of the surface is covered with a material the thermal properties of which are comparable with those of pumice. If $K$, $\rho$ and $c$ are the thermal conductivity, density and specific heat of the lunar material (assumed to be constant), $t_0$ is the duration of penumbra, and $A$ is the insolation before the eclipse, he gave the formula

$$\frac{4At^{3/2}}{3t_0(\pi K\rho c)^{1/2}} \qquad (1)$$

for the fall of temperature up to time $t$ after the beginning of penumbra, and from the observations deduced $(K\rho c)^{-1/2} = 120$, the units being c.g.s. and ° C. The source of this formula was not stated, but it is, in fact, that for the surface temperature of a semi-infinite solid from which heat is extracted at the rate $At/t_0$ per unit time per unit area. This is equivalent to assuming that the surface loses heat during the eclipse at a rate proportional to the fourth power of its initial temperature, instead of to the fourth power of its actual temperature, and since the temperature-range involved is from 370° K. to about 200° K., formula (1) will give values which are far too large. To get an accurate result, the non-linear equations must be studied numerically: this has been done recently by Wesselink[2], who finds a value $(K\rho c)^{-1/2} = 920$, and shows that this value is consistent with dust at low pressures (he does not point out the incorrectness of Epstein's calculation, and, indeed, states that their results agree, which by a coincidence they do, though, in fact, they are in different units).



We made similar calculations in connexion with the microwave observations of Piddington and Minnett[3], but have taken the matter a good deal further. In the accompanying graph, the dots show Pettit's[4] observations of the 1939 eclipse, while curve I is calculated for a solid with $(K\rho c)^{-1/2} = 1{,}030$: the main discrepancy between the two is the fact that the experimental curves fall much more slowly than the calculated ones in the umbral phase. This discrepancy is not removed by changing the value of $(K\rho c)^{-1/2}$, which simply moves the later parts of the curves up or down. Two possible explanations may be suggested: (i) that it is an effect of the variation of thermal conductivity with temperature; or (ii) that the solid is not homogeneous. With regard to (i), we can only say that we have not been able to reproduce the experimental curves with likely laws of variation of conductivity with temperature. With regard to (ii), however, it has been shown[3] that the microwave results cannot be explained on the assumption of a homogeneous solid, but that a good fit is obtained by assuming that a thin skin, of conductivity $K$ and thickness $d$, lies on a substratum with thermal constants $K'$, $\rho'$, $c'$, provided that the quantities are related by

$$d = 610\, K(K'\rho'c')^{-1/2} \qquad (2)$$

Assuming this surface layer to be dust with $K = 2.8 \times 10^{-6}$ (which with the reasonable values $c = 0.2$, $\rho = 1.7$ corresponds to the $(K\rho c)^{-1/2} = 1{,}030$ of curve I), we have repeated the eclipse calculation for various values of $d$ and $(K'\rho'c')^{1/2}$ satisfying (2). Curves II, III, IV and V of the figure are for the values 0.24, 0.17, 0.12, 0.05 of $d$ with the corresponding values of 140, 100, 70, 30 of $(K'\rho'c')^{-1/2}$. Since curve III gives the best fit, we conclude that the surface behaves like a layer of about 2 mm. of dust on a substratum for which $(K'\rho'c')^{-1/2}$ is about 100. This value corresponds to the terrestrial values for substances such as pumice or gravel and suggests that the surface consists of granular matter interspersed with dust which lies on top of it to a depth of about two millimetres.

Finally, it should be remarked that the observed temperature is an average over a small region of the surface, and that it is possible that portion of the region may be covered with bare rock and the remainder with dust. Curve VI shows the corresponding result for bare rock, $(K\rho c)^{-1/2} = 20$, and by combining this with the others it appears that it is unlikely that more than 5 per cent of the surface is bare rock.

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Aug. 14.

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[1] Epstein, P., *Phys. Rev.*, **33**, 269 (1929).

[2] Wesselink, A. J., *Bull. Astro. Inst. Netherlands*, **10**, 351 (1948).

[3] Piddington, J. H., and Minnett, H. C., *Aust. J. Sci. Res.*, **2**, 63 (1949).

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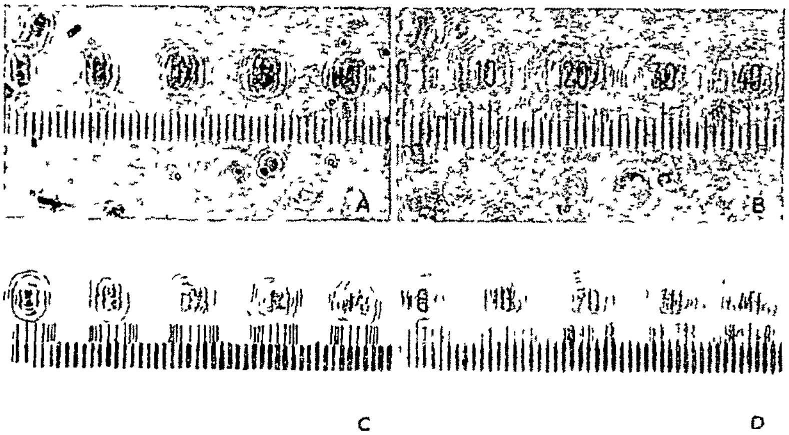
## The Black and White Hologram

It has been shown[1] that there exists an analogy between a Gabor diffraction 'hologram' and a zone plate. This idea led immediately to the following experiment, which has been successfully carried out.

A bromide enlargement from a hologram (*A*) (part only is reproduced) was taken and all the important lines (as judged by the operator) were inked in with indian ink using a mapping pen. Attention was confined, so far as possible, to the fringes produced by the object (a micrometer eyepiece scale), those due to extraneous dirt being omitted. The silver image was next removed from the print with a Farmer reducer, leaving a black-and-white representation of the hologram (*C*). A transparency was then made from this for use in the reconstruction apparatus.



(*B*) shows a direct reconstruction from the original hologram (*A*) using the technique previously described without any intervening auxiliary lens. It is, in fact, a particular Fresnel diffraction pattern of *A*. (*D*) is a similar reconstruction from (*C*). It will be seen at once that (*B*) bears a close resemblance to the original microscope scale, as anticipated, and (*D*) bears a more distant but still recognizable relationship.

In comparing (*D*) with (*B*) the following differences between (*A*) and (*C*) should be borne in mind. (1) We have replaced a continuous-tone photographic representation by an abruptly changing black-and-white line drawing. (2) Owing to the difficulty of drawing the outer fringes (which are very fine) the system has in general been terminated at the third or fourth fringe. (3) Small errors in placing the lines on the fringes are, humanly speaking, impossible to avoid, especially where the 'wanted' fringes are partially obscured by 'unwanted' fringes.

In view of the first of these changes, search was made for possible 'high-order' images, as suggested in the previous communication. None was found.

Practical and theoretical work is at present in hand to ascertain whether the possession of a harmonic series of focal lengths is a special property of linear and circular zone plates of definite symmetry, or whether it may be expected in holograms in general.

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[1] Rogers, G. L. [*Nature*, **166**, 237 (1950).]

## Internal Pair Creation in Magnesium-24

The theory of quantum electrodynamics predicts the occasional emission of an electron-positron pair from an excited nucleus in place of a hard $\gamma$-ray. The probability of this event, or the 'pair conversion coefficient', has been calculated by Rose[1]. It is dependent on the quantum energy and on the multipole character of the nuclear transition.

We have examined the simultaneous emission of three particles (a decay $\beta$-ray and an electron-positron pair) from a sodium-24 source and made a measurement of the pair conversion coefficient for the 2.78-MeV $\gamma$-line. Internal pair creation in such a source could be due to either of the two $\gamma$-rays of magnesium-24, but the probability for the 1.38-MeV line would be very small as compared with that for the 2.78-MeV line.

Three Geiger counters (20th Century Electronic *B*6 type) were arranged symmetrically around a sodium-24 source, and the number of triple coincidences was determined. When corrections for random coincidences were made, the remaining triple counts exceeded those attributable to $\beta_{\gamma\gamma}$-coincidences by a factor of 10. An order of magnitude of $10^{-3}$ was estimated for the pair conversion coefficient after all corrections were made. It did not seem possible, however, to make a quantitative determination with this method, because the solid angle and efficiency of the counters could not be estimated with sufficient precision, particularly without knowledge of the energy distribution of the pairs. A previous study of this type by Bradt *et al.*[2] using thorium C″ was made difficult by internal electron conversion.

In a second experiment the emission of the positrons of the pairs was observed by detecting annihilation radiations. The positrons were stopped in a plastic material surrounding the source and the annihilation quanta were detected by two photomultiplier tubes (E.M.I. 1-in. aperture type, naphthalene–anthracene crystals). These were placed in coincidence (resolving time $1.5 \times 10^{-7}$ sec.) and on opposite sides of the source at 65 cm. distance. With this small solid angle ($10^{-4}$ of $4\pi$), coincidences due to the cascade $\gamma$-rays of sodium-24 are fewer than those due to pair conversion positrons. Annihilation coincidences were easily distinguished from all others by displacing the source out of the straight line joining the two detectors. A correction for the pairs created in the plastic material by the 2.78-MeV $\gamma$-ray was made by substituting a thickness of aluminium having the same electron stopping power, and repeating the measurement. From the $Z^2$ law and the observed increase of positron counts, a probability of $3 \times 10^{-4}$ was calculated for the creation of pairs in the plastic.

The sodium-24 sources (= 70 $\mu$C.) were measured after decay on a Geiger counter previously calibrated with another sodium-24 source the strength of which had been determined absolutely by the method of $\beta\gamma$-coincidence. The positron-detecting efficiency of the apparatus was measured with two standards. The first consisted of 900 $\mu$C. of radiothorium in a small lead cylinder; in this, positrons are both created and annihilated. Its effective positron strength

(3 μC ) was calculated from data on pair production and γ-ray absorption in lead

The second standard was a source of sodium-22 in a plastic mounting which had been calibrated against a cobalt-60 standard as follows The sodium-22 and cobalt-60 sources were placed successively in front of a counter screened by 3 cm of lead The ratio of counting-rates remained constant to within a few per cent as the thickness of lead was increased from 3 cm to 5 cm , justifying the assumption that all annihilation radiation is thus filtered off Since the γ-energy of sodium-22 (1 28 MeV ) is almost the same as the mean γ-energy of the cobalt-60 lines (1 25 MeV ), this comparison affords a convenient method of calibrating sodium-22 (and hence indirectly any position emitter)

These two standards agreed to within a few per cent

A final value of $(7\ 6 \pm 1\ 9) \times 10^{-4}$ was obtained for the pair conversion coefficient of the 2 78-MeV line of sodium-24 This agrees well with the theoretical result predicted for an electric quadrupole (Brady and Deutsch[3] have shown that this line is very likely to be a quadrupole transition ) Rae[4] obtained $(11\ 6 \pm 1) \times 10^{-4}$ for the pair conversion coefficient of the same line by a different method, the primary object of which was to determine the spectrum of the positron

We are indebted to Prof R E Peierls and Dr G K Horton for interesting discussions, and to Lord Cherwell for facilities in this Laboratory

*Note added in proof* In more recent measurements the positrons were stopped in beryllium instead of plastic A pair conversion coefficient of $(8\ 25 \pm 1\ 05) \times 10^{-4}$ was obtained

W MIMS
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Clarendon Laboratory,
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[2] Bradt, E , Halter, J , Heine, H G , and Scherrer, P , *Helv Phys Acta*, 19, 445 (1946)

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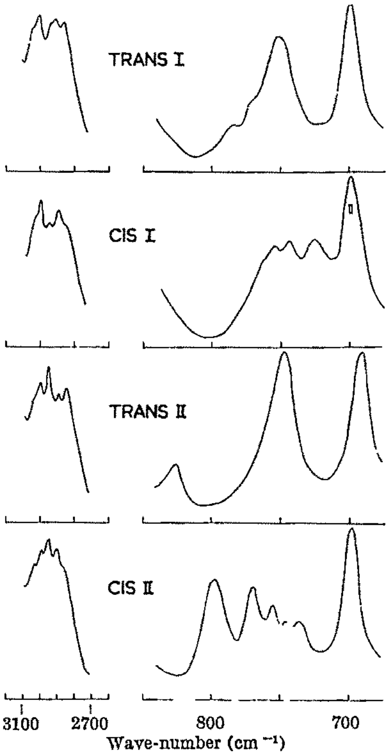
## Infra-Red Spectra of Unsaturated Aromatic Carbinols

THE infra-red absorption spectra of both the *cis-* and *trans*-isomers of phenyl propenyl carbinol (I) and styryl methyl carbinol (II) have been recorded in these laboratories Highly purified samples of these compounds were given to us by Dr E A Braude and Mr J A Coles The *trans*-isomers have been described previously[1] , the *cis*-isomers are new and their preparation will be described separately[2]

Ph CH(OH) CH=CHMe (I)
Ph CH=CH CH(OH)Me (II)

In view of the current interest in the C—H deformation frequencies of *cis-* and *trans*-olefines[3-5] and unsaturated alcohols[6,7], parts of the spectra are reproduced here The *trans*-isomers were expected to absorb at 965 $\mathrm{cm}^{-1}$ and the *cis*-isomers in the 650–750 $\mathrm{cm}^{-1}$ region

The 965 $\mathrm{cm}^{-1}$ region is unfortunately complicated by absorption due to the COH-group At lower frequencies the *trans*-isomers gave the normal spectra of mono-substituted aromatics, namely, two strong bands at about 690 $\mathrm{cm}^{-1}$ and 760 $\mathrm{cm}^{-1}$. These two bands (presumably due to aromatic C—H deformation[8]) occur in the spectra of mono-alkyl benzenes, styrene and substituted styrenes, and benzyl and α-substituted benzyl alcohols



Spectra of unsaturated aromatic carbinols Spectra recorded on Perkin–Elmer 12*B* spectrometer 2,600–3,200 $\mathrm{cm}^{-1}$, no dilution, cell 0 025 mm , 650–850 $\mathrm{cm}^{-1}$, approximately 10 per cent solution in cyclohexane, cell 0 1 mm Absorption plotted upwards

The *cis*-isomers gave only 690 $\mathrm{cm}^{-1}$ absorption, the other one being replaced by a series of weaker bands We have, then, the expected absorption due to the *cis*-unsaturation but also a reduction in intensity of the aromatic band This occurs not only in the spectrum of (II), where conjugation might cause a change in frequencies associated with the phenyl group, but also in that of (I), where the unsaturation is separated from the ring

In view of this effect on the aromatic C—H deformation frequencies, the C—H stretching absorptions near 3,000 $\mathrm{cm}^{-1}$ were examined With the limited resolving power afforded by a rock-salt prism, it was found that both *trans*-isomers give a maximum at 2,850 $\mathrm{cm}^{-1}$ where the *cis*-isomers have only a shoulder This frequency seems too low for an aromatic C—H absorption

These differences in spectra afford an empirical method of identifying the *cis-* and *trans*-isomers No attempt has been made to interpret them in terms of molecular structure, although the information may be of use in assigning the absorption frequencies of similar molecules

Thanks are due to the directors of the Distillers Co , Ltd , for permission to publish this note

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W THAIN

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Distillers Co , Ltd ,
Great Burgh, Epsom, Surrey Aug 1

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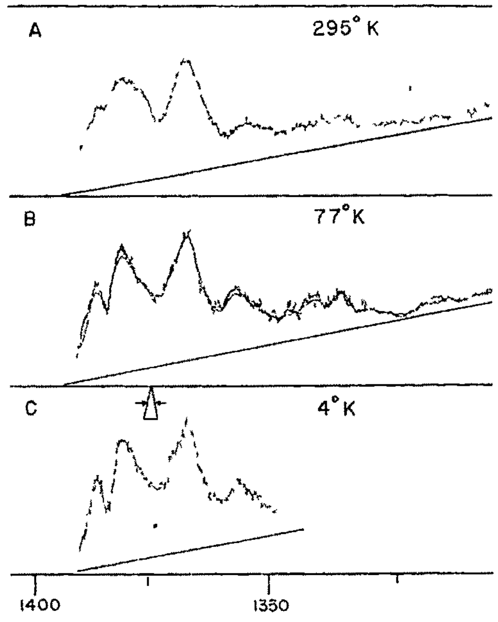
## Effect of Low Temperatures on Infra-Red Spectra

A MAJOR portion of infra-red spectroscopy to-day is directed toward the determination of characteristic vibrational frequencies of polyatomic molecules. In almost all cases the information is limited because the broad bands overlap. Cooling the sample to low temperatures offers the possibility that the natural width of each band is reduced sufficiently to resolve individual vibrational frequencies. The extent of the improvement has recently been the subject of a considerable amount of controversy. Walsh and Willis[1] and we[2] have pointed out that, in general, quantized rotation does not occur in condensed phases, so that one cannot agree with Avery, Morrison and Ellis[3], who stated that narrowing would obey the very strong law, $\sim T^{1/2}$, characteristic of rotational structure. However, we cannot agree with Walsh and Willis that narrowing can only occur through a change of state. On the contrary, on very general grounds[2,4], some narrowing would be expected from depopulation of the Debye acoustic waves, which are coupled with the molecular vibrations to give width to the bands.

We have subjected these ideas to fairly rigorous test by examining the infra-red spectra of a number of compounds at the temperature of liquid helium (4° K.)[2,5,6]. In order to interpret these spectra, we have made[7] a detailed treatment of resolving power and apparent width, taking into account the natural width of the bands, the aperture of the spectroscope, two finite slits, absorption of the prism, rate of scanning and the filtering of noise. The observed width is a transcendental function of the half-widths characterizing these factors, and can be roughly approximated as the square root of the sum of the squares, which explains why no startling changes are to be seen with present-day equipment. Applying the exact relation to data at 77° K. in the literature, we conclude the observed band-widths have been primarily determined by the experimental conditions. We have demonstrated this by re-examining the same or similar compounds at low temperatures with higher resolving power and have revealed more structure.



In our own spectra, the natural width at 77° K. is equal to that of the instrument, and at 4° K. the bands have become narrower. The accompanying illustration shows the spectrum of crystallized[8] cholesterol at 295° K., 77° K. and 4° K. (This work was done with a grant-in-aid from the American Cancer Society.) There is an increase in definition which we can interpret as a reduction in the natural width of the bands, without invoking a change of phase.

We conclude that considerably more detail of the spectra of such large molecules can be obtained at very low temperatures due to a reduction in natural band-width, provided the spectroscope has sufficient resolving power.

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Arthur D. Little, Inc.,
Cambridge, Massachusetts.
Oct. 9.

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[7] A detailed account of this treatment is to be published elsewhere.

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## New Source of Light for the Far Ultra-violet

THE Millikan spark[1], which is widely used in the far ultra-violet, presents some drawbacks because of the very high fields necessary for its initiation, and the instability of its operation. It is known that, at atmospheric pressure, very long sparks can be obtained with moderate potentials, if they are produced along the surface of a solid (sliding sparks). So far as we know, this spark had not been tried in a good vacuum, and it was not at all sure that it could be operated without an appreciable gas pressure. This communication describes a few results obtained with one type of sliding spark operated at low pressures.

Our experiments have been performed in a metallic spark chamber, evacuated by a diffusion mercury pump, followed by a liquid-air trap, the pressure being lower than $10^{-4}$ mm. mercury. The voltage is applied between two metallic rings mounted on a rod of commercial carbon resistor. The spark is supplied by the discharge of a condenser (0.03–0.1 μF.) charged at 30 kV. The spark chamber is mounted on front of the slit of a vacuum grazing-incidence grating spectrograph.

These experiments have been successful. Under the potential of 30 kV. the discharge is produced easily even for large interspaces (a few centimetres) between the electrodes. But this discharge does not look like the sliding sparks in gases, as its luminosity is mainly concentrated around the electrodes.

The negative electrode wears out, but this effect is slow, and the projections of solid particles are much weaker than in ordinary vacuum spark. Moreover, the sliding spark is stable in space and more steady than the Millikan sparks , it works without any adjustments at all during many hours (for a frequency of two sparks a second)

The spectra we have obtained with copper electrodes (separation 3 mm ), between 100 and 2000 A , are, at first sight, similar to those given by ordinary vacuum sparks, except that some carbon lines are also present From our results, it appears that 'sliding sparks' in vacuum will probably be useful as light sources for far ultra-violet spectrography The spectrographic study of various types of 'sliding sparks' in vacuum is now in progress

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[1] Millikan and Sawyer, *Phys Rev* , 12, 167 (1918) , *Science*, 50, 138 (1919) Bombke, "Vakuum spektrocospie" (Leipzig, 1937) Vodar, Progres récents dans l'étude du spectre U V Centre de perfectionnement technique (Cours conference No 1116, Nov 1943)

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## Muscle Fibres of the Rat Diaphragm

In the course of an investigation of nerve endings in the rat diaphragm, it was noticed by Dr J A Hewitt and one of us (C S ) that the muscle fibres seemed to be of two types, reminiscent somewhat of the well-known pale and red fibres in voluntary muscles described by Jordan[1] and several others The 'red' variety seemed to be more numerous than the other Staining with iron hæmatoxylin after alcohol fixation (ideal for skeletal muscle) confirmed that there were two types, but unfortunately did not reveal any further distinguishing detail It was then decided to attempt their differentiation at the higher magnifications now possible with the electron microscope

The technique of specimen preparation was similar to that described by Hall, Jakus and Schmitt[2], but was slightly modified to suit our particular tissue A three-stage electron microscope built under the direction of Prof G I Finch was used for this work, with an operating voltage of 80–120 kV.

For the first part of our work specimens were prepared from fresh pieces of diaphragm in the relaxed state Krause's membrane is not confined to one myofibril, but is continued through those adjacent to it. The myosin filaments can be resolved in some specimens but not all, and extend throughout the length of the fibril No limiting membrane can be seen surrounding the myofibril

Two types of fibril were again observed in the electron microscope, which showed that though they are similar in most respects, they differ in their sarcomere lengths, especially after passive stretching (extending) This is due to a difference in the relative extensibilities of the *A* and *I* bands of the two fibrils, which is presumably a result of the difference in the structure of their *A* bands, since there is independent evidence that the *I* bands are similar, whereas the *A* bands are different in their staining reaction

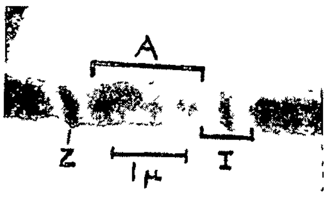

Fig 1 Electron micrograph of a myofibril from rat diaphragm in the relaxed state

For the second part of our work we compared stimulated diaphragm muscle fibrils in both the contracted and the relaxed states. The former was obtained by stimulating the phrenic nerve, allowing the fibres to contract isotonically and fixing them in this condition. The latter was obtained by stimulating, as before, another piece of diaphragm, and after isotonic contraction the stimulus was stopped , the muscle then lengthened to the relaxed state in which it was fixed

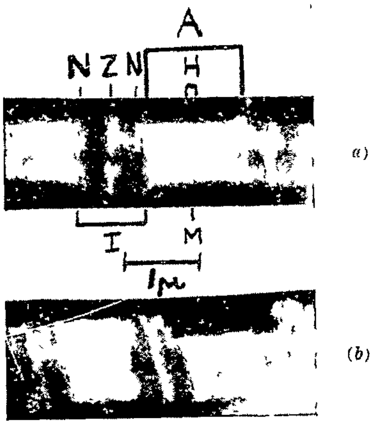

Fig 2 Electron micrographs of fibrils from (*a*) rat rectus and (*b*) rat diaphragm, both after stimulation The *H* disk and the *M* and *N* lines now appear

The fibrils from stimulated diaphragm exhibit more detail than those from one not so stimulated The *A* band now shows Hensen's disk with the *M* line within it, and the *I* band shows the *N* lines in some fibrils

Changes in sarcomere lengths in both 'pale' and 'red' fibres occurring of necessity in isotonic contraction are seen most noticeably in the lengths of the *I* bands

Our observations are in agreement with those reported by Hall *et al* [2] on leg muscles of the rabbit

A few observations were made on the rectus muscle of the rat, which indicate that similar structural alterations take place after stimulation

A fuller account of this work will be published elsewhere We wish to thank Prof G I Finch for his help and for giving us facilities in his laboratory, and Dr J A Hewitt for suggesting the original work and for criticism

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[1] Jordan, H E , *Physiol Rev* , 13, 301 (1933)

[2] Hall, C E , Jakus, M A , and Schmitt, F O , *Biol Bull* , 90, 32 (1946)

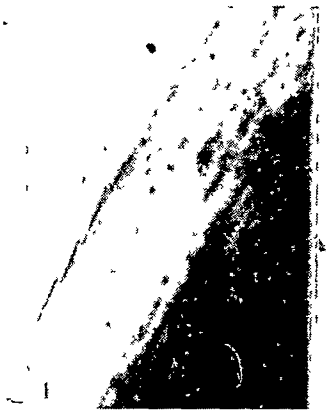
## The Cuticle of Mammalian Hair

Studies in these laboratories have suggested that the arrangement of scales in the cuticles of mammalian hairs can be more accurately revealed by the examination of fibre sections, using ultra-violet light, than by the use of the electron microscope This work has shown that the thickness of the cuticle of mammalian hair depends upon the arrangement of the component scales

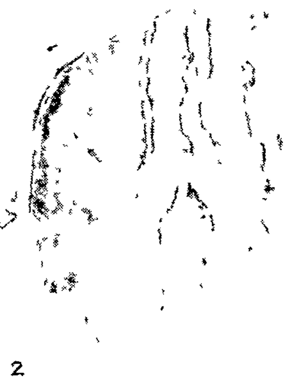
Thin transverse and longitudinal sections of human hair, hog bristle, alpaca and wool have been prepared at thicknesses varying from one to five microns After staining some of the sections by the Champy-Kull method and others with indigo-carmine, they were examined under the phase-contrast microscope and the normal microscope, using the 3650 A. line

Thickness of cuticle, as can be seen in a longitudinal section of human hair (Fig 1), depends upon the number of layers in the cuticle, these being formed by the amount each scale overlaps its neighbour The cuticles of human hair, hog bristle and alpaca are comparatively thick The whole cuticle can be seen quite clearly under the $\frac{1}{6}$-in objective, and individual scales which form the cuticle are clearly seen under the $\frac{1}{12}$-in objective In human hair these scales are approximately 0 33 micron thick and approximately 30 microns in length, the latter measurement being taken from a point on the lower margin of the scale, which abuts on to the cortex, to a point on the upper margin of the scale which is on the surface of the fibre (These measurements were made on photomicrographs of longitudinal sections of fibres ) Of this length, only about one-sixth forms the outer surface of the fibre, the remaining five-sixths being covered by the adjacent overlapping scale The result of this is a scale pattern where the scale margins are relatively close together, as seen in human hair and hog bristle

Longitudinal sections of Lincoln and Leicester wool fibres show that individual scales are approximately the same length as the scales in human hair but in some cases thicker, up to 0 66 micron. The proportion of longitudinal overlap is the reverse of human hair, namely, only approximately one-sixth of the total length is covered by another scale, and five-sixths of the length forms the outer surface of the fibre It may be noted that both these types of wool fibres have a scale pattern with scale margins fairly widely spaced


1

Longitudinal section (8 μ) of human hair (ultra-violet light, 3650 A , × 930)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Transverse section (5 μ) of Leicester wool fibre (phase contrast, × 1,000)

Both transverse and longitudinal sections of wool fibres show that the cuticle is much thinner than the cuticle of human hair, hog bristle or alpaca, due to a different arrangement of scales In a wool fibre the cuticle is only one scale thick except in parts where the scale overlaps Fig 2 is a typical example of a transverse section of a wool fibre In the other fibres mentioned above the cuticle is thick, due to closely overlapping scales In both types of fibres, scales overlap in a lateral direction, showing that one scale does not extend around the whole circumference of the fibre In human hair overlapping scales can be seen within and on the surface of the cuticle

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C M Greville

Wool Industries Research Association,
Leeds
Aug 18

## X-Ray Diagram and Ultra-Violet Absorption Spectrum of 'Renatured' Silk-Fibroin

Coleman and Howitt[1] have observed the interesting fact that if one dissolves denatured silk-fibroin in cupriethylene-diamine, a product is obtained which does not differ essentially from the native fibroin, and therefore they have called it the process of 'renaturation"

In an earlier communication[2] we have stated that the air-dried native silk gland gives a very sharp X-ray diagram which by means of mechanical treatment of the sample, for example, stretching and rolling, changes into the well-known diagram of the cocoon filament We suggested the names 'Silk I' and 'Silk II'. If 'Silk II' is treated with alkali, there appear small-angle interferences at the equator, which are due to a 45-A net plane distance in the side-chain direction This form of the silk we named 'Silk III'[3]

In view of these results, it seemed of considerable interest to investigate the renatured silk of Coleman and Howitt If the dialysed aqueous solution of the fibroin is dried *slowly*, films are obtained with the diagram of 'Silk I' Nevertheless, the diagram is much less pronounced than the diagram obtained from the native silk gland Only two reflexions allowed satisfactory measurement, namely, those with values of $D$ of 7 3 A and 4 4 A They correspond quite definitely, both in appearance of the diagram and density distribution in the diffuse background, with the reflexions formerly found of 7 5 and 4 5 A This points to a distinct, if insignificant, contraction of the lattice

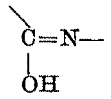
If moistened with 50 per cent ethanol, the renatured silk films could be stretched plastically more than 300 per cent without losing their solubility in water and without any increase in tensile strength The X-ray diagram of these stretched films shows no orientation But the sharp diagram changes into a smeared amorphous diagram with two maxima which are identical with the strongest reflexions of 'Silk II', about 9 2 A, corresponding with $A_1$, and 4-4 8 A, corresponding with the region of the strongest reflexions $A_2$ and $A_3$ [4]. Between crossed nicols, no birefringence is to be seen This gives the impression that a transformation is beginning from 'I' into 'II', which has, however, not yet led to the formation of long particles , hence on stretching there occurs a plastic deformation without any orientation

The transformation into the diagram of 'Silk II' with fibre orientation does not take place until the moistened films are stretched and rolled at the same time The strongest intensity of 'Silk I', with a net plane distance of 4 4 A , still remains as a continuous faint circle

Certain differences between this fibre diagram and that obtained by stretching and rolling the native silk gland could be observed Thus fibrous particles, when stretched approximately 100 per cent, would lead to a much better orientation than is actually observed The weakness of the reflexions $A_1$ and $A_2$—the latter cannot be observed with any certainty—coinciding with the plane of the peptide grid probably indicates a disturbance or irregularity in the direction perpendicular to the backbone plane The dominating reflexions are $A_3$ and $I_3$ [4] Both these reflexions belong to the zone of the *c*-axis, indicating the side-chain direction

The treatment of renatured silk with hot alkali yielded no positive results , in particular, it did not lead to small-angle reflexions at the equator This fact, too, points to a low degree of order in the direction perpendicular to the peptide grid

The only effect of the hot alkali consisted in a distinct increase in intensity of the reflexions, that is, in an augmentation of the lattice-like part This effect is in good accordance with the ultra-violet spectrographic observation that treatment with alkali results in the appearance of an additional absorption band at about 4,000 mm $^{-1}$ This band has been ascribed to the enolic form of the peptide group[5]



which is possible only on the basis of extended systems of interchain hydrogen-bonds Thus, the alkali treatment leads, just as in the case of the native silk, to a better-ordered arrangement within the plane of the peptide grid The renatured silk, however, is unable simultaneously to form a long-range order in the side-chain direction Coleman and Howitt emphasize that rapid drying of the fibroin solution is necessary for obtaining samples which show on stretching an increase in tensile strength and birefringence They say, furthermore, that these samples give the normal β-diagram of the silk (corresponding to 'Silk II') Judging from the mechanical and optical behaviour, we believe that what these authors were working on was, in fact, 'Silk II' If, on the other hand, the solution is dried slowly, 'Silk I' will be formed as stated above

Thus, we may conclude that the mechanical deformation, stretching and simultaneous rolling, has the same effect as the rapid drying mentioned by Coleman and Howitt The fact that these authors are able to identify in their solutions a globular form of the protein confirms our opinion that 'Silk I' obtained from this solution by drying very slowly represents a globular protein[2]

Our investigations are being continued We are much obliged to J Lapp and W Berndt for preparing the silk samples

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## Diffusion of Copper along the Grain Boundaries of Nickel

LANGMUIR[1], when studying the thermionic emission of filaments for electronic valves, reported that the diffusion of thorium in tungsten may be a hundred times faster along the grain boundaries than through the grain itself Van Liempt[2] and Zwikker[3], respectively, gave similar results for molybdenum and carbon in tungsten Mehl[4] stated that copper diffused preferentially along the grain boundaries of aluminium, but that there was no detectable preferential grain-boundary diffusion of carbon, nitrogen or hydrogen in iron Also Seith and Keil[5] were unable to detect any grain-size effect in the self-diffusion of lead Evidence is given in this communication showing that copper diffuses preferentially along the grain boundaries of nickel

Thin copper and nickel strips of commercial purity, stacked alternately, were annealed in an atmosphere of hydrogen to remove the surface oxide films, and then hot-rolled together This treatment gave very good bonding between the two metals, and no flaws could be seen microscopically in the interfaces Nickel and copper were chosen because they have complete solubility and hence there are no intermediate phases to complicate the diffusion zone After annealing the sandwich at 1,000° C for 36 hr in an argon atmosphere, the cross-sectional surface was polished on emery papers to grade 000 and then electrolytically polished using a bath of one part concentrated nitric acid and two parts methyl alcohol A current density of 1 5 amp /cm $^2$ for 3 sec with 20 V across the cell was sufficient to remove the mechanically worked material, and by rapidly interrupting the current about three times at the end of this treatment it was possible to pit the material with a high nickel content without etching the copper-rich material The accompanying photomicrograph (Fig 1) shows that the concentration contour is quite sharp, and that the copper diffused more rapidly along the grain boundaries of the central nickel than through the grains themselves

It is of interest that twin boundaries in the nickel do not influence the diffusion-rate, there being no modification of the advancing concentration contour at twin boundaries, for example, *AB* (Fig 1) This fact is in accord with the suggestions made by Beck, Sperry and Hu[6] to explain their results on the

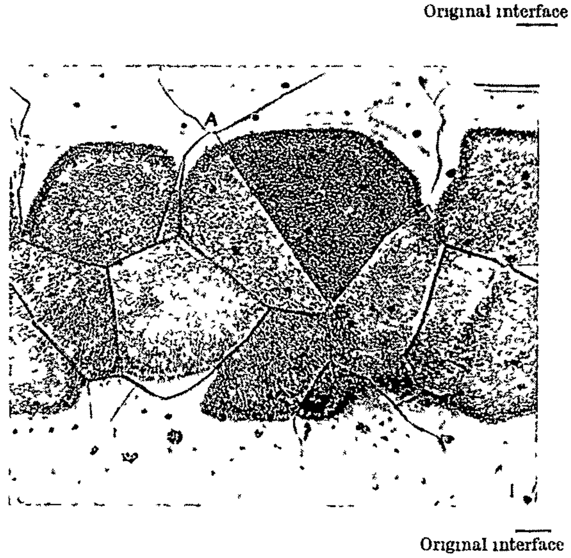


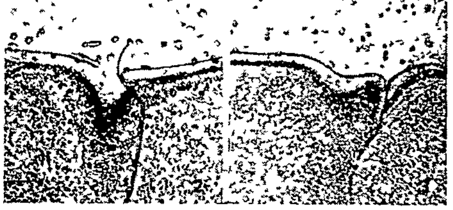
Fig. 1. Micrograph of copper–nickel sandwich showing the preferential diffusion along the grain boundaries but not the twin boundaries (for example, *AB*) of the central nickel. (× 325)

dependence of the rate of grain boundary migration on orientation.

Figs. 2 and 3 show examples of the movement of a grain boundary from the position where it has caused a V-shaped inlet in the concentration contour to a new position, and are proof that the diffusing copper atoms do not lock the nickel grain boundaries and prevent grain growth. The boundary in Fig. 2 has moved from its former position quite late in the annealing process as there is no inlet centred upon its present position, while that in Fig. 3 has moved to its present position sufficiently early during annealing for a new inlet to be formed and for the old inlet to lose its sharpness.

It may be noticed that Figs. 2 and 3 both contain two concentration contours. It was found that by suitable choice of current density, one, two or three concentration contours could be made to show on the micrograph, some of these contours being as sharp as grain boundaries.

The extent of the penetration of copper along a grain boundary of the nickel cannot be used as a measure of the rate of diffusion, as it is dependent upon the length and inclination of the boundary. However, the angle of the apex of the concentration contour at a grain boundary may be used as a measure of the relative rates of diffusion along the grain boundary and through the crystal lattice. Measurements of this nature on various grain boundaries in Fig. 1 give values of between 1·5 and 4 for the ratios of the diffusion-rates. Micrographs with more than one concentration contour show that the ratio becomes less as the concentration of the copper increases.



Grain boundary which has moved to its present position. Fig. 2 (left) at the end of the anneal, Fig. 3 (right) quite early in the anneal. (× 325)

There is no indication in Fig. 1 that the volume diffusion of copper into the nickel is dependent upon the orientation of the grain, and this is as expected in cubic metals.

This simple method of studying grain boundary diffusion has the advantage of bringing out clearly the details of the processes, whereas the method of measuring the diffusion coefficient as a function of grain size gives only a statistical result. The method can be used to study recrystallization and grain growth caused by diffusion, as a detailed study of the micrographs gives information upon the existence and position of grain boundaries during the whole period of annealing. The shape of the concentration contours where they cross grain boundaries will give valuable information on the ratio of grain boundary to lattice diffusion and thus on the nature of the grain boundaries themselves.

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## Molecular Models

The report of a method of making Stuart-type molecular models in plastic[1] prompts us to describe a procedure evolved here which is very cheap and requires only very simple means.

From a standard model of each atom a copy can quickly be made with the kind of charcoal used for blow-pipe analysis. A wire is stuck into one face and the copy slowly lowered into a crucible of molten scrap type-metal until the face bearing the holding wire is level with the surface of the metal. After agitating the metal for a while to dislodge air bubbles, it is allowed to solidify. The charcoal is then dug out piecemeal and the inner faces of the mould carefully polished. This is tedious but largely determines the appearance of the finished models.

In some cases, split moulds are needed and these are made by sawing the metal in half, making an aluminium gasket and arranging some pegs to register the two halves.

Any number of final models can now be made from the mould by pouring in polyvinylchloride paste (for example, "Welvic" grade *PA*2), suitably coloured with pigments. The mould is closed by a metal plate and *G*-clamp, heated for 15 min. at 160° C. and the model stripped from the mould after cooling in water.

The separate atoms can be welded together permanently by a hot knife or joined by ⅛-in. pegs or by small dressmaker's press-studs. The female portions of these may be moulded into the appropriate faces of the models, where they are well anchored by the polymer. To fit into these, a small pin with a head size just fitting the press-studs may be pressed into the adjacent atom model. From such atoms it is possible to construct strong models with free rotation at any desired point

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## A Water-Labile Fungistatic Extractive characterizing Living Trees

The ability of living trees to resist attack by common fungi which destroy dead branches and lumber from these same trees seems to be in need of explanation This problem is made more interesting by the fact that some wood-destroying fungi, such as *Schizophyllum commune* Fries, are in general unable to cause serious trouble even in wounded living trees

The following method was used to demonstrate the fungistatic properties of extractives from catalpa (*Catalpa speciosa* Warder) Ground samples of heartwood, sapwood (the outer annual ring), and bark were extracted with 95 per cent ethyl alcohol Pieces of filter paper were placed in the filtrate and then sterilized and dried in a hot-air oven Two pieces of the filter paper were placed one inch apart on potato dextrose agar in a 'Petri' dish *S commune* was then inoculated into the agar equidistant from the papers Filter paper similarly treated but placed in alcohol only was used in controls Inhibition of radial growth was found to be in proportion to the concentration of extractive used—with heartwood extract giving most inhibition, followed by sapwood and then bark Fungistatic materials have also been obtained by hot-water extraction, although, even after boiling in water for three hours, alcoholic extractives of high inhibiting potency have been demonstrated in the wood Studies of materials from other tree species indicate a general prevalence of similar fungistatic substances, there being a quantitative difference in distribution For example, the elm (*Ulmus americana* L ), the fallen timber of which is rapidly subject to decay by *S commune*, contains comparatively small amounts of the inhibiting substance in wood taken directly from living trees

Alcoholic extracts have retained their antibiotic nature, but water extracts have been found to lose this property rapidly It has also been shown that there is a negative correlation between fungistatic capacity of alcoholic extractives and the length of time the branches are stored at room temperature in laboratory air or in water

The fungistatic substances here described may be similar or identical with those previously reported but not correlated with relative resistance of living and dead trees[1,2], etc This, and the ability of the extractive to inhibit other fungi, is yet to be determined That there may be a connexion between these fungistatic materials and growth-regulating substances is suggested by the observation that dilute concentrations seem to have a stimulating effect[3] Whatever the nature of these materials, the results of the experiments here reported present evidence that living trees contain substances which rapidly lose their antibiotic qualities upon the death of the tree

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## Mechanism and Significance of the 'Refractory Period' in the Avian Testis Cycle

Burger[1] asserts that the "problem of refractoriness is perhaps the greatest relatively unsolved problem in reproduction" This problem, except in its ultimate details, may, in fact, have been solved[2] It can be said that the "refractory period" (of Bissonnette[3]) or "dead sexual season" (of Polikarpova[4]) in seasonal birds is that part of the testis cycle during which the tubules are in a state of post-spermatogenetic lipoidal metamorphosis, and before the newly regenerated Leydig cells of the interstitium have become sufficiently mature and lipoidal to respond to neuro-humoral influences initiated by factors in the environment.

At the termination of spermatogenesis, the epithelial contents of the tubules metamorphose and disintegrate, the tubules themselves become reduced in diameter and the whole organ collapses Concurrently, the exhausted Leydig cells (almost denuded of their lipoids during the last stages of the sexual season) of the old generation disappear, and there arises a new generation in the spaces between the shrunken tubules Fibroblasts suddenly appear in great numbers and rapidly build up a new *tunica albuginea* just inside the old testis wall that has become thin, distorted and fragile due to its enormous spring expansion and to its sudden collapse during tubule metamorphosis

This phase of breakdown and re-organization is associated with the post-nuptial moult and is probably responsible for the period of complete, or almost complete, sexual quiescence that now ensues Also, during this time, experimental birds are 'refractory'—they cannot be forced into spermatogenesis by means of photostimulation When the interstitium becomes again responsive, many species undergo a characteristic post-nuptial sexual display[5] This occurs while the latter phase of the moult is still proceeding and while the tubules are still partially, and sometimes massively, lipoidal (Marshall and Coombs, unpublished) Most of the necrotic sperm debris has, however, been eliminated The 'refractory period' varies in duration from species to species

In the light of the above, it can be readily understood why Bissonnette and Wadlund[6] were unable quickly to achieve a second experimental spermatogenesis by photostimulation, and why Riley[7] failed to obtain light-induced spermatogenesis in September, yet succeeded in doing so in November Likewise, Riley's success in stimulating juvenile birds in September becomes understandable, since these had not already undergone spermatogenesis and interstitial exhaustion and so their tubules had not metamorphosed and their developing lipoid Leydig cells were receptive to neurohumoral stimuli induced by the additional illumination.

The above-described tubule steatogenesis differs markedly from that which has long been known to occur in the semeniferous tubules of non-seasonal man In adult man the abundant sudanophil material comes almost exclusively from changes in the Sertoli cells and not from cyclical germ-cell breakdown Further, unlike those of birds, the tubule lipoids of man are not cholesterol-positive (Marshall and Boswell, unpublished) It is of interest that during the single, restricted period of the year when the endocrine Leydig cells of the seasonal bird are very immature and wholly inactive, the lipoids within the neighbouring tubules give a strongly positive reaction for cholesterol, the probable precursor of the androgens Further, an equally well-marked cholesterol reaction is obtained in atretic follicles of the regressed avian ovary

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## Growth Inhibition of a Yeast by Uracil, and its Reversal by Arginine

ADENINE, guanine and uracil have been shown by Holland and Meinke[1], to inhibit the growth of *Streptococcus fæcalis* R , the inhibition being reversed by serine We have observed a similar inhibition of the growth of a yeast, *Saccharomyces cerevisiæ* strain *D C L* 349, by uracil, which is reversed by arginine

The synthetic medium used contained glucose, mineral salts, ammonia, biotin, pantothenic acid, aneurine, pyridoxine, inositol and nicotinamide, with or without adenine, guanine and xanthine The addition of concentrations of uracil greater than $1\ 5 \times 10^{-5}$ *M* to medium inoculated with 10 μgm./ml of yeast 349 and shaken at 30° inhibited the growth for about four days, whereas at $0\ 1 \times 10^{-5}$ *M* there was, in some cases, slight stimulation Without uracil the yeast grew to completion in 24 hr L-Arginine added at about one-third of the concentration of uracil completely reversed the inhibition over a range of $0\ 5\text{–}50 \times 10^{-5}$ *M* DL-Citrulline at concentrations forty times greater had a similar action to L-arginine The inhibitory effect was not counteracted by twenty other amino-acids, including ornithine, added singly or in combination, or by folic acid, urea, or the guanidine bases glycocyamine, creatine, agmatine and guanidine The growth of nine other yeasts, *S cerevisiæ* strain *D C L* 211, *S. cerevisiæ* strain *alpinus*, *S. carlsbergensis* 4428, *S. macedoniensis*, *S logos*, *S fragilis*, *Torula colliculosa*, *T. cremoris* and *Kloeckera brevis*, was slightly stimulated by uracil, rather than depressed The specificity of the action of uracil was tested by substituting the following related compounds, none of which showed a similar effect namely, alloxan, alloxantin, allantoin, cytidine, *iso*cytosine, barbituric acid, *iso*-barbituric acid, orotic acid, 5-amino-uracil, 5-nitro-barbituric acid, dialuric acid, violuric acid, *iso*-violuric acid, 2-thiouracil 2-methyl-4-amino-5-ethoxymethyl-pyrimidine and thymine

In view of a similar antagonism described by Volcani and Snell[2] between arginine and its structural homologue canavanine, a sample of canavanine, kindly given by Dr C J O R Morris, was tested and found to inhibit the growth of typical strains of the genera of yeasts mentioned above, and in all cases the effect was reversed by arginine Hence it is concluded that canavanine effects a mechanism which is common to most yeasts, whereas the action of uracil is of a more specific nature

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## Phase Coloration in Larvæ of Lepidoptera

ABOUT thirty years ago Uvarov brought forward the 'phase' theory of locusts and showed that young hoppers when crowded together developed differences in colour, structure, behaviour and physiology from similar larvæ kept individually separate The former were known as the phase 'gregaria' and the latter as 'solitaria' Gregaria are always darker in colour than solitaria

In 1943 Faure announced the discovery of phases in larvæ of two South African Lepidoptera of the family Noctuidæ, *Laphygma exigua* (the lesser army worm) and *L exempta* (the army worm), with the possibility of its occurrence in a third species *Spodoptera abyssinia*

We have recently carried out two repetitions of an experiment on larvæ of *Plusia gamma* (the silver-Y moth), in each case from a single batch of eggs, some of the larvæ crowded and others kept solitary All the solitary caterpillars remained pale green, while the crowded larvæ changed from a green darker than that of the solitaries to an extremely dark coloration These laboratory experiments are supported also by some field observations (which led to the investigation) in which unusually dark larvæ were associated with mass outbreaks

It is curious to note that, with the exception of *S abyssinia*, all the Lepidoptera in which phases have been demonstrated are migratory species, similar to the locusts, but why there should be the connexion and if it is more general cannot yet be answered

Further experiments are now in progress on the chemical and physical aspects of the physiological differences, and on the behaviour patterns, in *P gamma* and also in other species such as *Pieris brassicæ* (the large cabbage white butterfly), which is a well-known migrant, and other non-migratory Lepidoptera

Fuller details will be published later

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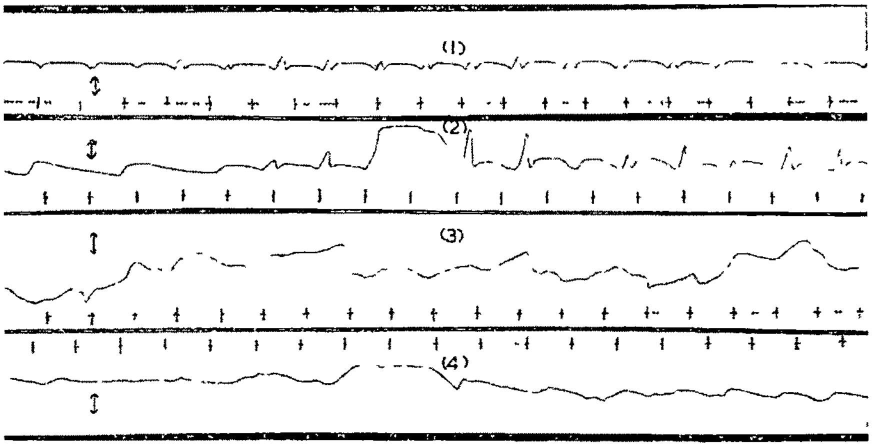
## Nystagmus following an Emotional Disturbance

SINCE it is possible that eye movement research will have important clinical applications[1], the photoelectric corneal reflex method[2,3] has been applied to the study of a case of nystagmus.

The subject is a male, twenty-two years of age, and, apart from the nystagmus, free from pathological conditions. The history is that, at the age of nine years, an enforced change from left- to right-handedness produced a nervous crisis the aftermath of which was the nystagmus. There is now no subjective disturbance in vision, and, to the best of the subject's knowledge, the nystagmus has not changed since its inception. The movements are visible to the unaided eye and any emotional upset causes a considerable increase in their magnitude; the movements appear to be confined to the side-to-side direction.

Figs. 1 and 2 show side-to-side binocular fixation records for the left and right eye respectively for the subject sitting up. The magnitude of the movement necessitated the use of wedges[4] rather than straight-edges; even so, no satisfactory record of the movements of both eyes simultaneously has yet been obtained. Figs. 1 and 2 show the nystagmus some 7 min. from the beginning of fixation; initially, the movements are too large to record with the existing apparatus; this is also the case after prolonged fixation. At an intermediate stage, as the beginnings of Figs. 1 and 2 show, the phenomenon disappears almost entirely. It appears that the nystagmus is of neither the usual pendular nor the usual jerky type[5]; it is, however, characteristically regular, interval 0.23(7) sec.



(1) and (2) Side-to-side records for the left and right eye respectively. Towards the time-line corresponds to a rightward movement.
(3) and (4) Up-and-down records for the left and right eye respectively. Towards the time-line corresponds to an upward movement.
Time (increasing to right) marked by dots, 50 per sec., and by lines at 1/5 sec. intervals.
Amplitude shown at side; height of arrowed line represents a rotation of 2° for Figs. 1 and 2, of 2° for Figs. 3 and 4; it is assumed that the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5.3 mm.

Figs. 3 and 4 show up-and-down records for the left and right eye respectively under the same conditions as for Figs. 1 and 2. These records are not very different from those of normal subjects[3].

It would appear that these results provide one more illustration of the close linkage between psychological and physiological phenomena.

I am greatly indebted to Mr. J. S. Swain for acting as subject in this investigation, and I wish to express my thanks to Dr. W. D. Wright for helpful criticisms. I also acknowledge the continued financial support of the Medical Research Council.

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## Penicillin in the Aquarium

AXOLOTLS were hatched from eggs in the laboratory and kept in an open tank. Progress was satisfactory until they were about 1 in. long (8 weeks), when considerable numbers died suddenly, suggesting an epidemic infection. Two days previously there had been an unusual number of people present in the room. As many pathogenic agents are susceptible to penicillin, we added 10 units/ml. to the water of the aquarium, which was then not changed for 24 hr. After this, there were no more deaths. Shortly afterwards we had similar losses among our edible frogs, kept in a shallow tank. Penicillin was added to the water, a higher concentration—20 units/ml.—being used to allow for the slower entry into the larger animals. There was an immediate and striking reduction in the mortality-rate to a figure no greater than normally experienced with these animals at that season.

Though no attempt was made to demonstrate a pathogen beyond the microscopic observation of a Gram-positive diplococcus in both cases, we feel that the observations might be of interest to others responsible for the maintenance of aquaria.

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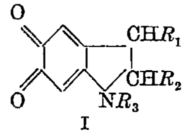
## Synthesis of 5:6-Dihydroxyindole Derivatives: an Oxido-reduction Rearrangement Catalysed by Zinc Ions

IT has recently been shown[1] that adrenochrome (I, $R_1$ = OH, $R_2$ = H, $R_3$ = Me) is rapidly converted into the isomeric 3:5:6-trihydroxy-1-methylindole



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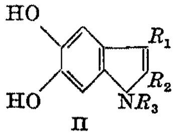


II

(II, $R_1$ = OH, $R_2$ = H, $R_3$ = Me) by the action of zinc acetate in aqueous solution. We have now found that this interesting catalysed oxido-reduction rearrangement is general for compounds of the type (I) and provides a very convenient synthetic route to dihydroxyindoles which are of interest as melanin intermediates

Thus, 3 4-dihydroxyphenylalanine, on treatment with 4 mol equivalents of potassium ferricyanide and sodium bicarbonate, gives a deep red solution of a quinone (I, $R_1 = R_3 = H$, $R_2 = CO_2H$), which on treatment with an excess of zinc acetate, removal of the precipitated zinc ferrocyanide by centrifugation and extraction of the aqueous solution with ether, gives an excellent yield of 5 6-dihydroxyindole (II, $R_1 = R_2 = R_3 = H$), identical with that synthesized by a longer route by Beer, Clarke, Khorana and Robertson[2]

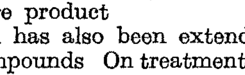
The red quinone can also be obtained by oxidation of 3,4-dihydroxyphenylalanine with tyrosinase or silver oxide[3], but the use of potassium ferricyanide, as described above, is much superior for preparative purposes Exactly similarly, 5 6-dihydroxy-1-methylindole (II, $R_1 = R_2 = H$, $R_3 = Me$), earlier prepared by one of us[4] by the reduction of adrenochrome, was obtained from N-methyl 3,4-dihydroxyphenylalanine In both the above cases, rearrangement and loss of carbon dioxide have occurred simultaneously, conforming with the observations of Mason and Wright[5]

Application of the above procedure to 3 4-dihydroxyphenylethyl methylamine (epinine) also gave 5 6-dihydroxy-1-methylindole in good yield, the oxidation with silver oxide and subsequent isomerization with alkali reported by Burton[6] gave a poor yield of impure product

The reaction has also been extended to halogen-substituted compounds On treatment with potassium iodate, epinine gave a red crystalline iodo-quinone (I, $R_1 = I$, $R_2 = H$, $R_3 = Me$, m p 85–87° decomp ), which with zinc acetate gave pale yellow 5 6-dihydroxy-3-iodo-1-methylindole (II, $R_1 = I$, $R_2 = H$, $R_3 = Me$, m p 88–90° decomp ) That the iodine atom does not occupy the 2-position is shown by the fact that the diacetate (m p 146–147°) of our product differs from the diacetate[7] (m p 153–155°) of the isomeric 2-iodo compound

2-Iodoadrenochrome[8] (I, $R_1 = OH$, $R_2 = I$, $R_3 = Me$) on treatment with zinc acetate and afterwards with sodium dithionite gave 3 5 6-trihydroxy-1-methylindole, the iodine atom being removed by the reducing agent

In agreement with the Belgian authors[1], we have found that apart from aluminium, which, however, gives much less satisfactory results, zinc is the only metal the ions of which are effective in catalysing the rearrangement It seems probable that the effect is due to the intermediate formation and subsequent decomposition of a zinc complex



III

In support of this view, we have obtained an insoluble dark-green zinc complex (III) by the oxidation of catechol in the presence of zinc salts As written above, it is represented as containing one benzenoid and one *o*-quinonoid nucleus, though, in fact, it is undoubtedly a resonance hybrid in which the two nuclei are in an equivalent intermediate state of oxidation

Further work on this rearrangement, particularly with regard to the mechanism and possible biological significance, is in progress and will be reported in full elsewhere

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[2] *J Chem Soc*, 2223 (1948)

[3] Dulière and Raper, *Biochem J*, **24**, 239 (1930)

[4] Harley-Mason, *J Chem Soc*, 1276 (1950)

[5] *J Biol Chem*, **180**, 235 (1949)

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## Use of Lithium Aluminium Hydride in the Study of Carbohydrates

STRUCTURAL studies of polysaccharides containing uronic acid residues involve the identification of the uronic acid and the determination of the manner in which it is joined to other sugar residues in the polysaccharide[1,2] The identification of the uronic acid usually presents little difficulty if the modified methods of hydrolysis[3,4], coupled with chromatographic analysis[5,6], are applied. The nature of the linkage between the uronic acid residue and the other sugar components has been ascertained by periodate oxidation[7] and by methylation studies The former method is of limited application whereas the latter, which involves the identification of a methyl derivative of the uronic acid, has been widely employed[2,8,9,10] The identification can be time-consuming when reference substances are not available, and occasionally it presents difficulty inasmuch as removal of the glycosidic methyl group, which often forms part of the identification procedure, is accompanied by decarboxylation and decomposition

A consideration of the properties of the methyl derivatives of uronic acids and of the corresponding sugars will show that if reduction of the carboxyl group at $C_6$ to a primary alcoholic group could be effected, the structural problem would be greatly simplified not only because the reduced compound would be more readily hydrolysed by acid and more stable during hydrolysis of the glycosidic group, but also because most of the partially methylated aldohexoses that would be formed have been characterized This reduction step has been carried out in one or two cases by catalytic reduction[11,12,13], but, unfortunately, rather drastic conditions have to be applied, and not infrequently hydrogenolysis accompanies hydrogenation and the yield of the desired product is small

We have recently found that lithium aluminium hydride ($LiAlH_4$), shown by others to reduce the carbonyl group[14,15,16], will also reduce the carbomethoxy group of uronic esters to a primary alcoholic group The reduction proceeds rapidly at room temperature in inert solvents such as ether and tetrahydrofuran to give good yields By this method we have reduced the methyl esters of 2 3 4-trimethyl methyl-D-galacturonoside, 2 3 4-trimethyl-α-methyl-D-glucuronoside and 4-methyl-methyl-D-glucuronoside[10,17] to 2 3 4-trimethyl-methyl-D-galactoside, 2 3 4-trimethyl-α-methyl-D-glucoside and 4-methyl-methyl-D-glucoside, respectively, the methyl ester of hexamethyl-6-β-D-glucuronosyl-β-methyl-D-galactoside has given 6-β-2 3 4-trimethyl-D-glucosyl-

2 3 4-trimethyl-β-methyl-D-galactoside (m p 145 5°, $[\alpha]_D$ − 39° in chloroform (c, 3 8), found C, 51 8, H, 8 3, $C_{19}H_{36}O_{11}$ requires C, 51 8, H, 8 3 per cent) Similarly, methylated pectic acid[18] gave a methylated galactosan, while methylated degraded arabic acid[19] afforded the corresponding neutral methylated polysaccharide, composed of methylated residues of galactose and glucose

The reducing property of lithium aluminium hydride can be widely applied in carbohydrate studies, for free sugars and their derivatives and lactones and their derivatives can be readily reduced to the corresponding alcohols For example, diacetone-mannose gave diacetone-mannitol, and 2 3 6-trimethyl-γ-D-mannonolactone afforded 2 3 6-trimethyl-mannitol

Further details of this work will appear elsewhere

*Note added in proof* Since this work was completed Lythgoe and Trippett (*J Chem Soc*, 1983 (1950)) have reported the use of lithium aluminium hydride for the reduction of the methyl ester of 2,3,4-trimethyl-methyl-D-glucuronoside

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[2] Jones and Smith, "Advances in Carbohydrate Chemistry", 4, 243 (Academic Press, Inc, New York, 1949)
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[4] Frush and Isbell, *J Res, Nat Bur Stand*, 37, 321 (1946)
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[11] Levene, Tipson and Kreider, *J Biol Chem*, 122, 199 (1937)
[12] Levene and Christman, *J Biol Chem*, 122, 203 (1937)
[13] Cf Levene and Kreider, *J Biol Chem*, 121, 155 (1937)
[14] Nystrom and Brown, *J Amer Chem Soc*, 69, 1197 (1947)
[15] Nystrom and Brown, *J Amer Chem Soc*, 69, 2548 (1947)
[16] Finholt, Bond and Schlesinger, *J Amer Chem Soc*, 69, 1199 (1947)
[17] Smith (to be published)
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[19] Smith, *J Chem Soc*, 1724 (1939)

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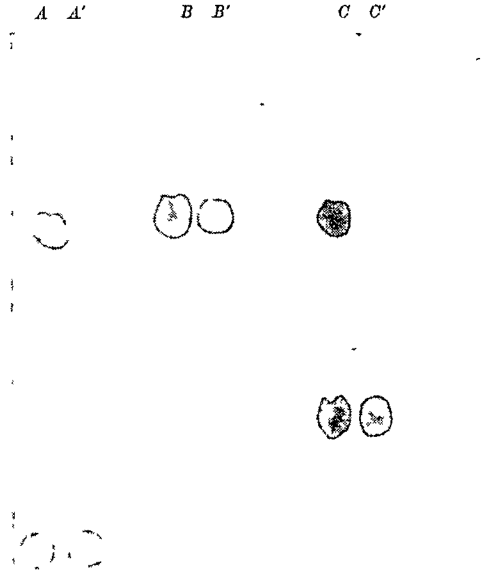
## A Micro End-Group Method for Peptides

A METHOD for the reductive methylation of peptides and amino-acids, recently published by Bowman[1], was used by him to identify as its N-dimethyl derivative the amino-acid in a peptide bearing the free amino-group Advantage was taken of the ready solubility of these derivatives in alcohol This elegant method is, however, not immediately suitable for micro-quantities As N-dimethylamino acids do not give a colour with ninhydrin, paper chromatography[2] of the hydrolysate of a methylated peptide should show the absence of the end amino-acid when compared with the hydrolysate of the original peptide Should this particular amino-acid also occur elsewhere in the peptide, then a diminution of the intensity of the relevant ninhydrin spot is to be expected

It has so far been possible to test the method only on the following peptides α-L-glutamyl-L-tyrosine, α-L-glutamyl-L-phenylalanine, glycyl-glycine, glutathione, glycyl-L-tyrosine, it is hoped later to investigate other peptides

0 2–0 5 c c of a 0 01 *M* solution of the peptide was poured into a 10-c c conical centrifuge tube fitted with a capillary gas inlet leading to the very tip of the tube One drop of aqueous formaldehyde (40 per cent) and a 'knife-point' of palladized char coal (5 per cent) were added and the tube placed i a thermostat at 40° C The air was displaced b nitrogen and then a slow stream of hydrogen wa passed into the suspension, followed again by nitrogen Hydrogenation for 4 hr was sufficient for th glycyl peptides, but in the case of the glutamyl peptide it was necessary to pass hydrogen for 10–12 hr Th catalyst was removed by centrifugation and th supernatant liquid evaporated six times with wate on the steam bath to remove formaldehyde prior t hydrolysis with 5 *N* hydrochloric acid at 100° C Th disappearance of the ninhydrin spot correspondin to the end amino-acid is shown in the photograph o the paper chromatogram In the case of glycyl-glycin (*B*, *B′*), a marked diminution of the intensity ca be seen, equal amounts of nitrogen were used Methylation of α-L-glutamyl-L-tyrosine gave result similar to the phenylalanine analogue The methylated amino-acids do not apparently fluoresce on dr paper



*A,A′* = α-L-glutamyl-L-phenylalanine, hydrolysed, before and after methylation, *B,B′* = glycyl-glycine, hydrolysed before and after methylation, *C,C′* = glycyl-L-tyrosine, hydrolysed before and after methylation Whatman No 4 paper, butanol/acetic acid (ref 3) as solvent for 16 hr

The method has the advantage that it can be use in aqueous solution under very mild conditions, an that it requires a minimum of manipulation, als there is no attack on tyrosine as in existing method On the other hand, this procedure cannot as yet b used for cysteine-containing peptides in which n methylation occurs Probably any free amino-group occurring in the side-chains of the peptide will als be methylated, but after hydrolysis the corresponding amino-acid should still give a ninhydrin spot though in a different position

I acknowledge a grant from the Research Fun of the Chemical Society

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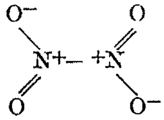
[1] Bowman, R E, *J Chem Soc*, 1349 (1950)
[2] Dent, C E, *Biochem J*, 43, 180 (1948)
[3] Woiwod, A J, *J Gen Microbiol*, 3, 312 (1949)

## Potential Barrier in Dinitrogen Tetroxide

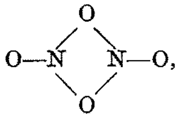
THE communication[1] by C K and E H Ingold n the structure of $N_2O_4$ reviews the chemical and physical evidence in favour of the various structures proposed for $N_2O_4$ The authors conclude that the tructure is



which is equivalent to the $D_{2h}$ structure proposed by utherland[2] on the basis of the spectroscopic data Using the fundamentals proposed by Sutherland and he following molecular dimensions, namely, ∠ ONO = 20°, $r_{NO} = 1\ 15$ A , $r_{NN} = 1\ 66$ A [3], the entropy at 98° K may be calculated by the usual methods of tatistical thermodynamics[4] In this way the entropy f translation for gaseous $N_2O_4$ at 298° K is found o be 39 44 cal /deg /mole, and that due to vibration nd rotation without taking torsion into account is 0 00 ± 0 3 cal /deg /mole (The error of ± 0 3 E U n the rotational entropy is estimated by assuming hat the error in each molecular dimension is ± 5 per ent ) The entropy observed by Giauque and Kemp[5] was 72 73 cal /deg /mole Thus the amount of ntropy contributed by the degree of freedom ssociated with internal rotation is 3 29 ± 0 3 al /deg /mole Assuming the potential energy is of he form $V = B/2\ (1 - \cos 2\varphi)$ the torsional frequency nd potential barrier $B$ are related to the moment of nertia about the torsional axis by $\nu = \frac{1}{2\pi}\left[\frac{8B}{I}\right]^{1/2}$ Then if the potential barrier is considered to be so igh that the contribution to the entropy is simply ue to a torsional oscillation, then the torsional requency is 108 ± 20 cm.$^{-1}$, with a corresponding arrier of 8 5 ± 2 cal /mole

On the other hand, if the barrier is not so high hat a torsional oscillation may be used in the partion function, the tables of Pitzer and Gwinn[6] for hindered rotator must be used From these tables nd the following values $I_m = I/4 = 27\ 5 \times 10^{-40}$ G S units, $n = 2$, $Q_f = 12\ 6$, entropy of internal otation = 6 06 E U , and $S_f - S = 2\ 77 \pm 0\ 3$ it found that the barrier is 9 2 ± 2 cal /mole This orresponds to a frequency of 112 ± 20 cm $^{-1}$ The arrier is evidently so high, ~ 9 ± 2 cal /mole, that oth calculations yield very nearly the same result

The molecular model proposed by Longuet-iggins[7], namely,



ith $D_{2h}$ symmetry was introduced as an alternative the ethylene-like structure of Sutherland to explain e spectrum and the abnormally long N—N distance[3] nd low N—N force onstant[8] This model as no torsional mode, owever, so that the alculated entropy nd observed entropy ffer by about 3 E U his lack of agreement strong evidence for cluding this model a possible structure

Since the repulsion of the oxygen atoms would stabilize the out-of-plane form ($D_{2d}$), there must be a strong interaction (⩾ 9 ± 2 cal /mole) stabilizing the planar form Resonance between the forms suggested by the Ingolds would be at a maximum when the structure is planar[9] and accounts for the stability of the planar form

The heat capacity $C_p^0$ at 298° K of $N_2O_4$ is calculated to be 17 11 cal /mole for a barrier of 9 cal /mole and 17 06 cal /mole for a completely hindered rotator. The available experimental results on the heat capacity of $N_2O_4$ are 11 4 cal /mole at 307° K [10] and 20 cal /mole at 300° K [11] An experimental redetermination of the specific heat seems to be indicated

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[2] Sutherland, G B B M , *Proc Roy Soc* , A, **141**, 342, 535 (1933)

[3] Maxwell, L R , Mosley, V M , and Denning, L S , *J Chem Phys* , **2**, 331 (1934)

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[8] Duchesne, J , *C R Acad Sci* , *Paris*, **204**, 1112 (1937)

[9] See, for example, Klotz, I M , *J Chem Educ* , **22** 328 (1945)

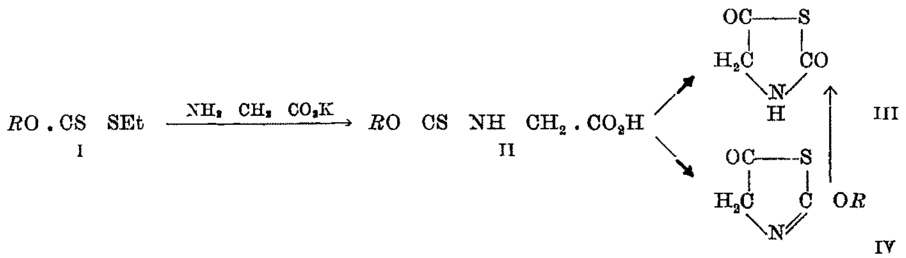
[10] McCollum, E D , *J Amer Chem Soc* , **49**, 28 (1927)

[11] Partington, J R and Shilling, W G , "The Specific Heat of Gases", 188 (London Ernest Benn, 1924)

## Synthesis of Thiazolid-2: 5-Dione

RECENT interest in the synthesis of polypeptides has centred around the ability of oxazolid-2 5-dione and its 3- and 4-substituted derivatives to polymerize with loss of carbon dioxide or to condense with amino-acids or their esters Cook and Levy[1] have now shown that the analogous 2-thiothiazolid-5-one and its 4-methyl derivative may also be used for the introduction of glycyl or alanyl residues Attempts by Cook, Heilbron and Hunter[2] to obtain the structural cross of the above heterocycles, that is, thiazolid-2 5-dione (III), were unsuccessful These authors were interested in the latter compound and its derivatives, as they considered they would be of a stability intermediate between that of oxazolid-2 5-dione and 2-thiothiazolid-5-one and would consequently be more easily handled The parent compound has now, unexpectedly, been obtained in good yield by the accompanying reaction scheme

A variety of potassium alkylxanthates (alkoxydithioformates) were esterified to give ethyl alkoxydithioformates (I), which condensed smoothly with potassium aminoacetate to give N-thiocarbalkoxyglycines (II) Cyclization of (II) with acetic anhydride gave the expected 2-alkoxythiazol-5-one (IV), the



reaction being quite analogous to the formation of 2-alkylthiothiazol-5-ones from N-dithiocarbalkoxyglycines observed by Cook, Harris, Heilbron and Shaw[3] The attempted cyclization of (II) with phosphorus tribromide or trichloride gave a crystalline product which was not (IV) and which was formed irrespective of the nature of the alkyl group, *R* The same product was obtained on treating (IV) in moist benzene with phosphorus trihalides Its identity as thiazolid-2 5-dione was indicated by analysis (found C, 31 2, H, 2 65, N, 11 6, S, 27 1 per cent, $C_3H_3O_2NS$ requires C, 30 75, H, 2 55, N, 11 95, S, 27 4 per cent) It forms inch-long laths (m p 110°) from water Its aqueous solution decomposes on heating or prolonged standing to give an insoluble precipitate, believed to be polyglycine, and a gas containing labile sulphur

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[1] *J Chem Soc*, 646 (1950)

[2] *J Chem Soc*, 1443 (1949)

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## Bleaching Reactions with Jute Fibre

BLEACHING of lignocellulosic materials with chlorine gas or with hypochlorous acid has been shown, in the case of unbleached wood-pulp[1], to take place through a series of reactions involving chlorination, demethoxylation and oxidation of the lignin The reaction products are of relatively small molecular weight and are readily soluble in solutions of sodium sulphite The rate of bleaching appears to depend upon the presence of the free phenolic or enolic hydroxyl group, known to exist in lignin, for Brauns[2] has shown, in the case of unbleached wood-pulp, that when this is blocked by a methoxyl group the rate of reaction of the lignin with a bleaching solution is greatly reduced

Partial acetylation of jute with a mixture of acetic anhydride and pyridine, as well as methylation with an ethereal solution of diazomethane, has now been shown to lead to a similar retardation of the rate of bleaching For example, while a lignin-free fraction can be isolated from raw jute, by the Cross and Bevan method, after three chlorinations and sulphite extractions, an acetylated sample requires as many as seven such treatments to achieve the same result Moreover, the colour reactions associated with lignin after chlorination in acid solution and addition of sodium sulphite are much less marked with the acetylated sample Unlike the non-acetylated material, in which an intense red colour develops in the cold immediately on adding sodium sulphite to the chlorinated lignin, the solution containing the acetylated material must be warmed, or even boiled, before any colour develops The colour reactions can be restored to the acetylated sample by hydrolysing it with a cold solution of dilute alkali

Another interesting property of partially acetylated jute is its behaviour to the action of light While raw jute, like most other lignocelluloses, becomes yellow or brown on exposure to light, similar treatment of a partially acetylated sample results in photochemical bleaching and there is a loss of acetyl groups from the sample[3] A comparison of the bleaching-rates, and colour reactions, of acetylated jute before and after exposure to the light of a mercury-vapour lamp has therefore been mad Since this leads to no change in either bleaching-rat or colour reactions, it is clear that those acetyl grou removed during irradiation are not those primaril responsible for retarding the bleaching reactions acetylated jute

I wish to thank the Executive Committee of th Indian Jute Mills Association Research Institut which sponsored this work

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Aug 26

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[1] White, E V, Swartz, J N, Peniston, Q P, Schwartz, H, McCarth J L, and Hibbert, H, *Tech Assoc Pap*, **24**, 179 (1941)

[2] Brauns, F E, *Paper Trade J*, **103**, 36 (1936)

[3] Callow H J, *Nature*, **159**, 309 (1947)

## Chess-playing Machines

IN the account in *Nature* of October 14 of machin which carry out strategic sequences of moves, it stated "No machine can learn from its mistakes– to improve the play the programme must be im proved"[1] It is, of course, true that a machine canno learn unless it is provided with a programme c mechanism for learning But it is quite possible t devise such a mechanism

Machines can be designed to make the best mov at each step in a game of noughts-and-crosses o (in theory) draughts or chess But when playin against a series of human opponents, such a machin may never do much better than draw A good huma player against the same opponents may score mor wins by making unsound but more puzzling moves Can a machine be made to imitate the human player Instead of playing perfectly, can it be made to pla well ? It can, by the inclusion of an empirical o statistical mechanism, in three units One unit make the machine experiment with different alternative each time certain positions are reached, the secon unit counts the results and relates them to th alternatives chosen, and the third steers the machin into the lines of play which have been winning mos often

Indeed, the mechanism may be made more subtl The second unit could also be made to classify player say by their opening moves, into the bold and th timid The third unit would then, in a given en game, choose the move which had won most ofte against players of that type

Thus it is possible to programme a machine s that it learns, matures and even develops a styl We do so by putting in a mechanism which estimate the probability of success in the future by analysin the distribution of successes in the past Perhap this is not the way in which animals learn, or pe haps, on the contrary, it is the very reason wh animals play games at all But I am confident tha the inclusion of such statistical mechanisms will b an important development in machines I can speal for its usefulness in strategic problems, for I mysel used it in a rudimentary form in bombing studies in those spacious days when we worked with punche cards

J BRONOWSKI

Central Research Establishment
of the
National Coal Board
Oct 15

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[1] *Nature*, **166**, 644 (1950)

# FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

## Monday, December 18

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m —Discussion on "Have Post-War Broadcast Receivers taken Full Advantage of War-time Development ?" (to be opened by Mr R B Armstrong)

Royal Geographical Society (at 1 Kensington Gore, London, S W 7), at 8 15 p m —Dr V E Fuchs "Latest Explorations in British Antarctica"

## Tuesday, December 19

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S W 7), at 2 30 p m —Dr H H Green and Dr Ruth Allcroft "Copper-Molybdenum Relationships in Disorders of Ruminants" *

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 30 p m —Mr Paul Bloomfield "The Ideal of an Elite" *

Institution of Civil Engineers (at Great George Street, London, S W 1), at 5 30 p m —Prof R H Evans "Research and Developments in Pre-Stressing" (Unwin Lecture)

Manchester Geographical Society (in the Geographical Hall, 6 St Mary's Parsonage, Manchester), at 6 30 p m —Mr T Nigel Browne "Parts of Southern Italy"

Society of Chemical Industry, Plastics and Polymer Group at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W 1), at 6 30 p m —Mr A Fowler Williams "A New Monomer, Acenaphthylene, its Polymers and Copolymers"

## Wednesday, December 20

Royal Meteorological Society (at 49 Cromwell Road, London, S W 7), at 5 p m —Mr G K Batchelor "The Application of the Similarity Theory of Turbulence to Atmospheric Diffusion", Mr J M Craddock "Advective Temperature Change in the 1000–700 mb and 700–500 mb Layers"

Royal Society of Medicine, Comparative Medicine Section at 1 Wimpole Street, London, W 1), at 5 p m —Discussion on "The Comparative Biology of Natural Fibres"

Institute of Petroleum, Stanlow Branch (joint meeting with the Liverpool Section of the Royal Institute of Chemistry, at the Grosvenor Hotel, Chester), at 7 15 p m —Apparatus Symposium

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the following dates

Assistant Physicist at the Royal Northern Hospital and Prince of Wales General Hospital Joint Radiotherapy Centre—The Secretary, Northern Group Hospital Management Committee, Royal Northern Hospital, Holloway, London, N 7 (December 23)

Chemist (with a good honours degree or equivalent professional qualification) in the Executive's Laboratory Service at Chiswick, responsible to a senior chemist for the work of a small section dealing with paints—The Staff Officer, London Transport Executive, 55 Broadway, London, S W 1, quoting I/EV 149 (December 23)

Experimental Officer (with a university degree in botany or agriculture, and a recognized agricultural diploma)—The Honorary Director, Unit of Experimental Agronomy, Department of Agriculture, The University, Oxford (December 23)

Lecturer (Grade II) in Metallurgy—The Secretary, The University, Birmingham 3 (December 23)

Senior Lecturer in Quantity Surveying, and Studio Masters (3), for the School of Architecture, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, Gordon Square, London, W C 1 (December 23)

Superintendent (Protective Coatings) in the Executive's Research Department at Derby—The Secretary, Railway Executive, 222 Marylebone Road, London, N W 1 (December 23)

Lecturer in Chemistry—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S W 3 (December 27)

Assistant Inspector (Forestry) in the Ministry of Agriculture—The Secretary, Civil Service Commission, Stormont, Belfast (December 29)

Scientists, Grade III (with a good honours degree in chemistry), in the Coal Survey Laboratories at Chester and Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1, quoting TT/274 (December 29)

Physicist or Engineer to undertake development work in connexion with electronic apparatus for spray assessment—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (December 30)

Principal of the Egerton School of Agriculture, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/266 (December 30)

Senior Experimental Officers, Experimental Officers and Assistant Experimental Officers at Admiralty Experimental Establishments in the vicinity of London, Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth Mechanical Engineers Ref No C 632/50A) who have had research and development experience in light mechanisms, Electrical Engineers (Ref No 368/50A) who have had experience in telecommunications, radar, electronics or light electrical mechanisms, Physicists (Ref No A 335/50A) interested in general physical problems, electronics or acoustics—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (December 30)

Senior Lecturer or Lecturer in Preventive Medicine and Public Health—The Registrar, The University, Leeds 2 (December 30)

Senior Psychologist to the East African Institute of Social Research attached to Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 30)

Senior Scientific Officers and Scientific Officers at Admiralty Experimental Establishments in the vicinity of London Baldock, Greenock, Haslemere, Portsmouth, Rosyth and Weymouth Physicists (Ref No A 336/50A) capable of undertaking research or development in general physical problems, electronics, acoustics or thermodynamics, Electrical Engineers (Ref No D 367/50A) qualified to undertake research, development or design in telecommunications, radar, electronics, instrumentation or light electrical mechanisms, Mechanical Engineers (Ref C 631/50A) capable of design, development or research work in light mechanisms, structures or hydrodynamics—The Ministry of Labour and National Service Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting the appropriate Ref No (December 30)

Analyst to take charge of regular chemical analyses of water samples—The Director, Freshwater Biological Association, The Ferry House, Faw Sawrey, Ambleside, Westmorland (December 31)

Lecturer in Botany (preferably in the special fields of either plant physiology or mycology) at Malaya University—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 31)

Plant Pathologist in the Department of Agriculture, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/267 (December 31)

Professional Engineers in many Departments of the Civil Service, for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London W 1, quoting No 3225 (December 31)

Professor of Agriculture (Soil Science) at the Canterbury Agricultural College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 31)

Principal Scientific Officer to be responsible under the Superintending Scientist, Propulsion Research Laboratory, Adelaide, for organizing the Engineering Group of the Laboratory, etc —The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S W 1 (January 2)

Sugar Cane Expert in the Department of Agriculture, Peradeniya—The Office of the High Commissioner for Ceylon in the United Kingdom, 13 Hyde Park Gardens, London, W 2 (January 5)

Scientist, Grade II (with a good university honours degree or its equivalent in chemistry) on the staff of the Director of Scientific Control at London headquarters—The National Coal Board, Establishments (Personnel) Hobart House, Grosvenor Place, London, S W 1, quoting TT/278 (January 6)

Henry Bell Wortley Chair of Metallurgy—The Registrar, The University, Liverpool (January 13)

Scientist, Grade III (with a good honours degree (or equivalent) in mathematics, physics or engineering) in the Field Investigation Group of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London S W 1, endorsed TT/279 (January 13)

Head of the Department of Chemistry and Biology, Liverpool College of Technology—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (January 15)

Lecturer in Anatomy at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth 5 Gordon Square, London, W C 1 (January 15)

Museum Assistant in the Geology Department—The Secretary, University College, Gower Street, London, W C 1 (January 15)

Professor of Civil Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 15)

Lecturer in Physics at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 22)

Gardiner Chair of Bacteriology—The Secretary of University Court, The University, Glasgow (January 30)

Cow and Gate Fellowship for research into problems associated with nutrition in infants and children—The Registrar, The University Manchester 13 (January 31)

Professor of Applied Mathematics at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 31)

Research Fellowship in the Department of Astronomy, Australian National University—The Administrative Officer in the United Kingdom, 27 Russell Square, London, W C 1 (February 1)

Senior Lecturer in Chemical Pathology at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (February 1)

I C I Research Fellowships in Biochemistry, Chemistry Engineering, Pharmacology or Physics—The Secretary, The University, Edinburgh (March 1)

Professorship in the Department of Physics—The Registrar, University of Manitoba, Winnipeg, Canada (March 31)

Assistant Professor of Anatomy—The Dean, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada

Chemist or Biochemist (with first- or second-class honours) for research in animal nutrition, with special reference to dietary factors affecting digestion—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire

COMPUTER to undertake computation of geodetic, astronomical and cadastral surveys and the preservation of records, in H M Colonial Service, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27076/41

DESIGN ENGINEERS to design and develop special small mechanisms, gadgetry and process tools (work will mainly consist of designing and developing apparatus for the remote handling of substances through various manufacturing processes)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

GEOPHYSICIST (graduate in science and/or mining engineering) in the Mines Department of South Australia—The Agent-General for South Australia, Marble Arch, London, W 1

JUNIOR and SENIOR ASSISTANTS FOR THE CHEMICAL RESEARCH LABORATORY, Rheumatism Unit, Nether Edge Hospital, Sheffield—The Chief Administrative Officer, United Sheffield Hospitals, The Royal Hospital, Sheffield 1

PLANT BREEDERS IN THE DEPARTMENT OF AGRICULTURE, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1 quoting No 27059/44

PLANT GENETICIST to carry out research on the genetics of sisal at the Sisal Research Station, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/171

RESEARCH OFFICER (with honours degree in chemistry) to undertake work on the behaviour of coals during utilization in relation to their structure and constitution, and an ASSISTANT CHEMIST for the physical chemistry section—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey

SENIOR PHYSICIST, attached to the Radiotherapy Department—The Secretary, London Hospital, Whitechapel, London, E 1

SENIOR SCIENTIFIC OFFICER (with experience in some branch of textile research) IN THE CHEMISTRY DEPARTMENT—The Director of Research, Linen Industry Research Association, Lambeg, Co Antrim

SURVEYOR to carry out special duties in charge of levelling in Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27076/23

TECHNICAL CHEMIST (with a first-class degree in technical chemistry and some industrial experience)—The Divisional Controller, British Electricity Authority, South East Scotland Division, British Electricity House, Portobello, Midlothian

TECHNICAL LIBRARIAN (with a good honours degree in science) in the Division of Atomic Energy (Production), Windscale Works, Sellafield, Cumberland, to organize and supervise a scientific library, a scientific and technical information bureau and ancillary services of a large research department—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs

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# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

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Agricultural Research Institute of Northern Ireland Twenty-third Annual Report, 1949–1950 Pp 43 (Hillsborough, Co Down Agricultural Research Institute of Northern Ireland, 1950) [209

Library Association Pamphlet No 3 Library Binderies By R F Drewery Pp 40+4 plates (London Library Association, 1950) 3*s* 6*d* 2*s* 9*d* to members [209

Ministry of Fuel and Power Report of the Committee of Inquiry into the Precautions necessary to secure Safety in the use of Explosives in Coal Mines Pp 52 (London H M Stationery Office, 1950) 1*s* 6*d* net [209

The Star Almanac for Land Surveyors for the Year 1951 Prepared by H M Nautical Almanac Office Pp xiii+66 (London H M Stationery Office, 1950) 3*s* net [209

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Philosophical Transactions of the Royal Society Series B Biological Sciences No 618, Vol 234 The Motor Nervous System of the Starfish, *Astropecten irregularis* (Pennant), with special reference to the Innervation of the Tube Feet and Ampullæ By J R Smith Pp 521–558 (London Cambridge University Press, 1950) 10*s* 6*d* [219

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Colonial Office Colonial Advisory Council of Agriculture, Animal Health and Forestry Publication No 1 Report of a Survey of Problems in the Mechanization of Native Agriculture in Tropical African Colonies Pp ix+124+16 plates (London H M Stationery Office, 1950) 4*s* 6*d* net [310

Colonial Office Report by H M Government in the United Kingdom of Great Britain and Northern Ireland to the General Assembly of the United Nations on the Administration of the Cameroons under United Kingdom Trusteeship for the Year 1949 (Colonial No 262) Pp xvi+384+8 plates (London H M Stationery Office, 1950) 10*s* 6*d* net [510

Bulletin of the British Museum (Natural History) Entomology Vol 1, No 4 The Type Specimens of certain Oriental Eucosmidæ and Carposinidæ (Microlepidoptera) described by Edward Merrick, together with Descriptions of New Eucosmidæ and Carposinidæ in the British Museum (Natural History) By A Diakanoff Pp 273–300+plates 3–8 (London British Museum (Natural History), 1950) 8*s* [510

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Australian Journal of Applied Science (4 times a Year) Vol 1, No 1, March Pp 132 (Melbourne Government Printer, 1950) 30*s* per annum [209

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The Natural Forest Inviolate Plot, Akure Forest Reserve, Ondo Province, Nigeria By the late A P D Jones Pp iii+33 (Ibadan Nigerian Forest Department, n d) [209

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# DEVELOPMENT AND EXPANSION OF TECHNOLOGICAL AND TECHNICAL EDUCATION

THE long-awaited report on the development of higher technological education in Great Britain, prepared by the National Advisory Council on Education for Industry and Commerce, has now been issued* It will be remembered that misgivings were expressed when the examination of this question was entrusted to that Council, rather than to the University Grants Committee, even if to do so would have involved enlarging the terms of reference of the latter body, and the result has justified those fears The whole trend of the long-drawn-out discussion on the expansion of higher technological education has been to emphasize the desirability, if not the necessity, of the expansion of university education and technological education being considered by the same body In fact, as the Parliamentary Secretary to the Ministry of Education admitted in the debate on education last May, neither falls within the province of the Ministry of Education, and it is to be hoped that this fact alone may induce the Minister, who has invited comments on the present report pending taking any decision on its recommendations, to leave a singularly inept report severely alone

For the purposes of this report, the Advisory Council regards higher technological education as referring to technological education in technical colleges of a standard at least equivalent to that of a university first degree, or satisfying the educational requirements for corporate membership of a major professional institution Nevertheless, while the Advisory Council recognizes that the provision of technological training cannot wisely be limited to one type of institution, and makes rather grudging acknowledgment of the contribution of the universities to technological education, it naively dismisses as irrelevant to its purpose the question of the establishment of one or more technological universities of a type new to Great Britain, or of the raising to university status of one or two existing colleges of technology The quantitative aspect is virtually ignored, nor does the Council even discuss the question whether technological education and technical training can be given within the same institution It is suggested, indeed, that advanced courses in technology should be concentrated as speedily as possible in colleges which are in a position to transfer elsewhere the whole, or the greater part, of their junior and less advanced work, and it would appear from this that the selected colleges would cease to fulfil the function of training technicians, for which they were originally established

Neither qualitatively nor quantitatively is the effect of any such development on the supply and training of technicians even considered in this report The supply and the quality of technicians is, however, a matter as vital to the industrial future of Great Britain as the supply and quality of technologists Moreover, technicians are required in even greater numbers than technologists, and their training is the only *prima facie* reason for the concern of the Minister of Education with technological education The Advisory Council disregards these considerations and treats with scant courtesy the contribution of the professional institutions, some of which have a record of more than half a century of conspicuous service in this field It also omits any consideration of the staffing problem—whether the selected technical colleges as at present constituted and governed are able either to attract the staff or arrange the courses which would provide the desired developments and improvements This is a matter on which Lord Eustace Percy spoke strongly in a recent address to the Education Group of the Institute of Physics

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* Ministry of Education The Future Development of Higher Technological Education, Report of the National Advisory Council on Education for Industry and Commerce Pp 28 (London H M Stationery Office, 1950 ) 1*s* net

The Advisory Council is of the opinion that the essential requirements for the development of education for technologists in the technical colleges of Great Britain lie in four main directions With the first two of these there will be general agreement First comes the further development of high-level courses of various kinds based on a sufficient scientific foundation, and conducted under conditions allowing the greatest possible freedom for experiment on the part of the lecturer and for research on the part of students and staff Second, a radical improvement is necessary in the finance, staffing, equipment and accommodation of the colleges, to enable them to develop such courses, to which many, agreeing with Lord Eustace Percy, would add a change in organization There will be a good deal of support, too, for the Advisory Council's rejection of various types of national body proposed, such as a technological grants committee for technical colleges, an association of professional institutions for raising standards, an association of colleges or departments of technology in a 'technical university' or a royal council of technology concerned with courses and awards at the first-degree level

It is from the third and fourth of the Advisory Council's recommendations that there will be dissent No cogent evidence is advanced in this report as to how, or why, either the establishment of new awards of high prestige to attract students to the courses and meet their desire for a higher technological qualification, or the establishment of a national educational body of high standing to appraise and assess the courses leading to such awards, and to assist in securing for technological education generally the recognition it needs, will contribute to the development of technological education in Britain Nevertheless, besides the development of new courses of advanced technology in the technical colleges in close association with industry and with the co-operation of the regional academic boards, and the consideration by the Minister of Education of increased financial aid to the authorities and a bigger allocation of building permits, the main recommendation of the report is the establishment of a national body with the title of 'Royal College of Technologists'

This body would not itself conduct examinatio or set syllabuses or take students, but would appro suitable courses of advanced technology submitt by technical colleges under conditions appropriate first and higher awards, and would approve th appointment of suitable external examiners to assi the colleges in setting and marking their ow examinations While the constitution of the pr posed College is dealt with in some detail, the repo ignores entirely the fact that any such ne awards could enjoy no greater prestige than that the institution in which they are won Their re impress would not be that of the awarding bod however distinguished, but that of the techni colleges in which they were won

Here we are confronted inescapably with th question of attracting highly qualified staff and providing all the necessary equipment and ameniti for a spacious education of the type required Link with this are the further questions whether su developments are possible while the technical colleg are owned and administered by local educati authorities, and without deflecting them from t no less important function of training technician If, in fact, the colleges are thereby deflected from training of technicians, the primary questions what alternative provision is to be made for t training of technicians, and how many, and whic technical colleges are to be thus diverted to t training of technologists exclusively

It is because the Advisory Council on Educati for Industry and Commerce has ignored these fund mental issues that its report is so unconvincing an even involves the risk, as Mr R A. Butler w prompt to point out at the autumn conference of t British Institute of Management, that a wron turning may be given to the development of tec nological education if its recommendations a adopted Apart altogether from the question wheth in the existing organization of the technical colleg under local authority administration it is, or is no inherently impossible to provide the conditions staff independence and the like which will attra men and women of professional calibre, it is, as S Frederick Handley Page, chairman of the Council the City and Guilds of London Institute, has pointe out, difficult for a local authority to allocate technical colleges the large sums required witho imposing a heavy burden on its ratepayers and doi a possible injustice to the other types of educati for which the authority is responsible. If the finan and development of technical education are not depend upon the vagaries of local politics and th ratable resources of local authorities, some at lea of the colleges must receive direct-grant aid in th same way as the universities do

The report, indeed, provides further evidence of th need for the development of higher technologic education in Great Britain being considered by th same authority as that responsible for the develo ment of university education Above all, it indicat the need for a quantitative approach to the w question of technological education, both where touches university education and where it affects th expansion of technical education Perhaps the Advisory Council on Scientific Policy, which although closely concerned with the matter is not directly involved, would put the weight of its authority behind such an inquiry, it should at least be able to command the support of the British Institute of Management and of leading industrialists, as was indicated in the discussion which followed Sir Ewart Smith's paper at the Birmingham meeting of the British Association

# DECLASSIFIED WORK ON UNDER-WATER EXPLOSIONS

## Underwater Explosions

By Robert H Cole Pp ix+437 (Princeton, N J Princeton University Press, London Oxford University Press, 1948) 42*s* net

A FEW weeks before the Battle of Britain, Sir Geoffrey Taylor suggested that I should attempt to calculate the pressure pulse caused by the detonation of an explosive charge of TNT in water, beginning with Prof H Jones's numerical values of the adiabatic of the detonation products The calculations were the most tedious I have ever made However, after four months I had a curve showing the form of the pulse at 50 charge-radii For the first time I was allowed to see the experimental results, a tracing made by Sir Geoffrey from a specially secret Admiralty report, produced by Sir Geoffrey after certain formalities had been observed The agreement between theory and experiment was encouraging Naturally, I wanted more data, and soon I was allowed to study Hilliar's report

Seldom does a secret scientific document compare in skill, insight and language with the outstanding scientific papers of any decade, but Hilliar's report, written in 1919, merits such comparison Mechanical ngenuity, a sound grasp of theoretical principles, and a wide and accurate range of experimental data in a hitherto almost unknown field are all there The formal, terse and impeccable language in which this humble scientific worker presented his results to the Lords of the Admiralty is delightful Sir Ernest Gowers could do no better.

The ban of secrecy on this and many other reports on the same subject has now been removed, and R H Cole's "Underwater Explosions" gives a very fine account of the present position. The book summarizes the main results of well over a hundred eports, many of them not yet published openly Free use is made of appropriate openly published papers and text-books The most recent papers naturally receive greater attention than the early nes, but some of the early papers were outstanding t the time when they were written

The subject as left by Hilliar was physics, the subject as it now stands revealed by Cole is techology The ubiquitous cathode ray tube and the efforts of many skilful and industrious mathematicians ave extended the state of knowledge shown in Hilliar's report, but only a few striking new ideas have been added

The book is divided into ten chapters, an appendix, bibliography and an index The chapter headings ve the sequence of events in an underwater xplosion, hydrodynamical relations, the detonation process in explosives, theory of the shock wave, measurement of underwater explosion pressures, photography of underwater explosions, shock-wave measurements, motion of the gas sphere, secondary pressure waves, and surface and other effects The appendix develops some of the approximations special to water in the Kirkwood–Bethe theory of the spherical propagation of an explosion pulse

Possibly the most interesting sections of the book are those giving the theory and the experiment of pulsating underwater bubbles, especially when modified by free and rigid surfaces Apparently the essentials of this problem were first formulated by an unknown examiner in a Cambridge Tripos examination in the eighteen-fifties Butterworth, in the Admiralty, during the interval between the two World Wars, rediscovered the problem and worked out many interesting features of underwater explosions During the Second World War, Taylor, Herring and others made considerable extensions An omission which is slightly disappointing is that the chapter on surface effects does not mention gravity waves caused by underwater explosions In a purely scientific sense, the gravity waves caused by explosions are most interesting and give substance to the brilliant theories of Cauchy and Poisson

There are very few misprints in the book, but Dr. A B Wood's name is mis-spelt as Ward in several places, both in the text and in the bibliography

As I have stated, many of the papers on which Cole's book is based have not yet been published This unfortunate situation is being corrected by the joint efforts of the United States Navy Department and the Admiralty. A compendium in three volumes on underwater explosions, containing many of the reports written during 1914–48 in America and the United Kingdom, is being prepared for open publication No known scientific fact in the fundamental physics of underwater explosions is being withheld. This compendium, together with Cole's book, will give a comprehensive account of the subject as it stands to-day

Cole's book is highly recommended for all physics and mathematics libraries on the grounds that it is well written, substantial and novel Students and research workers not concerned with the subject will find much to interest them. The photographs are entertaining and illustrate the theory in striking fashion

W G PENNEY

# ARCHÆOLOGY AND SCIENCE

## A Hundred Years of Archæology

By Dr Glyn E Daniel (The Hundred Years Series) Pp 344 (London Gerald Duckworth and Co, Ltd, 1950) 21*s* net.

ARCHÆOLOGY is, in many respects, a subject which links the humanities with science Its chief aim is to describe the early history of man on the basis of the relics of his handiwork (with the exclusion of written records), in other words, to supplement history, to extend it back to the beginnings of mankind and to develop a sort of prehistoric social anthropology But in addition, archæology seeks to trace the evolution of human technology and to reconstruct the ecology of prehistoric and early historic man In these respects it is intimately connected with geology, palæontology, physical anthropology and comparative anatomy As in the aims of archæology, so in its methods do two fundamental branches of learning join In part, the methods are related to those of the history of art, in part, however, they are essentially scientific, for it must be remembered that virtually all the material on which the archæologist bases his deductions is excavated from a geological context.

As a distinct discipline, archæology is scarcely more than a hundred years old Its foundation was influenced by the great controversies about evolution and the origin of man which occupied men's minds prior to the Darwinian period It germinated in the cabinets and museums of the classical antiquarianism of the outgoing eighteenth century It began to enlarge its scope when stone tools of early man were found together with the remains of extinct animals on the Somme, in the caves of South Devon and elsewhere, when the Swiss lake-dwellings were discovered and explored, and when the Danish peat-bogs began to yield the treasures which led to the establishment of the three-age system of Stone, Bronze and Iron All these were developments which occurred prior to 1850

Dr G E Daniel has undertaken to trace from these beginnings the development of modern archæology, and in particular of prehistoric archæology In doing so, he discusses the antiquarian background of archæology, the impact of the great development of geology and palæontology about the middle of the nineteenth century, the subsequent birth of modern archæology and the unfolding of archæological activities in many parts of the world, though mainly in the countries adjacent to the Mediterranean Sea A particularly pleasant feature of the book is the treatment of the great personalities concerned, whose life-stories are given Mariette, Schliemann, Pitt Rivers and Sir Flinders Petrie may be mentioned as examples

The twentieth century is characterized by an expansion of prehistoric research, especially in Europe, and by the great development of the techniques of archæological exploration, excavation and research It is in this latest phase that science has exerted an ever-increasing influence on archæology. Theories of evolution and of palæoclimatology, methods of physical geology like the investigation of raised beaches, of river terraces and of æolian deposits, botanical methods like pollen analysis and the identification of woods, the methods of estimating absolute age which are comprised by geochronology, have all more or less profoundly influenced the outlook of the archæologist Modern excavations such as those carried out by Prof R E M Wheeler at Maiden Castle in Dorset and at the Roman trading port of Arikamedu in South India are examples of efficient stratigraphical analysis of a sequence of deposits of which a trained geologist might be justly proud In the field of exploration, aerial photography has come to the help of the archæologist The real foundations of this application of a scientific technique were laid by O G S Crawford, archæological officer to the Ordnance Survey of Great Britain The archæological interpretation of air photography is rather more than a mere analysis of topographical features Differences in the composition of the soil, and of the vegetation growing on it ('crop-marks'), play an important part

The scientific worker who has an interest in the origins and the unfolding of human civilization will find Dr Daniel's book profitable reading, and what else is civilization but a very complex case of animal ecology, of adaptation of a peculiar species of mammal to a variety of environments ? Admittedly, the book is written from the angle of the prehistoric archæologist, not from that of the scientific man, but it is a good thing to have a definite point of view in syntheses of this kind No doubt another author would have written a different book. It is to the credit of Dr Daniel that he has succeeded in dealing with so much matter that this work will be useful as a source-book to all those who are interested or become involved in the developments of archæology

F E ZEUNER

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# AN INTRODUCTION TO NEWTON

Isaac Newton

By E N da C Andrade (Personal Portraits Series Pp 111+8 plates (London Max Parrish and Co Ltd, 1950) 6*s* net

PROF. E N DA C. ANDRADE'S book, "Isaac Newton", is the third in the series of "Persona Portraits" written by distinguished contemporary authors and published by Max Parrish and Co each of the selected authors being invited to write about the person whose life has most deeply influenced him In conformity with the general plan to the series, Prof Andrade tells in a short prologue his reasons for making Newton his choice how, as a boy, he found in Newton the "leader of Those Who Know, as against Those Who Write or Those Who Play Cricket", how, at the university, his enthusiasm revived through reading extracts from Newton's works in Preston's "Light" He explains that his aim in the present book has been to set down what he himself when young would have liked to know about Newton.

To convince the reader that Newton is one of the great heroes of humanity, Prof Andrade begins by showing the esteem in which Newton has been held by famous men of science, past and present, at home and abroad This is followed by an account of his early life and of the great discoveries made before he was twenty-four the calculus, the composition of white light, the law of gravitation So that the magnitude of Newton's innovations may be properly appreciated, the position of science in 1665 is reviewed and it is shown how Newton's approach to scientific problems differed from that of his predecessors

Prof Andrade then goes on to describe Newton's later work in optics the reflecting telescope, which he not only designed but made entirely himself, even to the preparation of the alloy for the metallic mirror the first published paper (February 1671/72), in which the famous experiments on the composition of white light were described, the criticism it provoked and the unfortunate effects of this criticism, especially Hooke's, on Newton's attitude to publication In connexion with Newton's second paper (1675), in which what is generally known as his corpuscular theory of light is set down, Prof Andrade points out that though Newton considered light to be "possibly" a stream of small swift particles of various sizes, yet in his theory of "fits of easy reflexion and easy transmission" he gave to light periodic properties just where the wave theory has to invoke them Some account of the "Opticks" and its famous "Queries" is included here, though this work was not published until considerably later.

The next period (1675–99) saw the publication of the "Principia" (1687) Enough is said of the ontents of this great work to give the reader some dea of what it achieved

In 1699 Newton was appointed Master of the Mint, "his periods of intense devotion to science at an end". The story of the remaining years of his life s followed, in the last chapter, by an understanding and sympathetic estimate of his character

The prologue rather suggests that this book is ntended for "the young" , certainly Newton's work s presented shorn of all, or nearly all, its difficulties It is, however, as a valuable and scholarly introduc-ion, not only to Newton and his work, but also to he whole of this important epoch in the history of cience, that the book is recommended to young and not-so-young alike N H de V Heathcote

## ANIMAL BEHAVIOUR

### Wild Animals in Captivity

By Dr D Hediger Translated by G Sircom. Pp x+207+17 plates (London Butterworths Scien-ific Publications, Ltd , 1950 ) 35*s* net

THE study of the behaviour of wild animals in captivity has hitherto received comparatively little attention, and Dr D Hediger's "Wildtiere in Gefangenschaft", published in 1942, was the first attempt by a trained zoologist to collect information on the subject An English translation of this work, evised and brought up to date, has now appeared and will be welcomed by all interested in animal behaviour The author, director of the Basle Zoo-ogical Gardens, has had a wide experience of animals both in captivity and in the wild, to which is added knowledge of animal psychology The result is an authoritative treatise which may help to correct ome of the mistaken notions concerning animals in aptivity, usually the result of an anthropomorphic approach to the subject

A proper appreciation and understanding of life in aptivity must obviously be based on a careful study f life in the free state, yet in the case of most species his information is very incomplete, especially in such nportant details as territorial requirements It is enerally assumed that in Nature animals enjoy nlimited freedom of movement , but this is far rom the truth, since the majority of them are not nly restricted to certain geographical areas but also particular habitats, and in addition their dis-ibution is dependent on relations with other cupants of the territory The author shows that y attention to such details it is usually possible, ven within the restricted area of a zoological garden, meet the physiological and psychological requirements of most species

The quality of the environment is shown to be of e greatest importance for the welfare of animals, d many interesting examples are given of the quirements of different species in captivity These ay be fundamentally different from the human idea comfort, as, for example, in the case of the loris, *ycticebus coucang*, which prefers its cage to be aked with its own urine Apart from the physical rroundings, the biological environment is of equal portance, for some animals prefer to live in close dily contact with other individuals, not necessarily the same species On the other hand, some animals efer to be at some individual distance, and do not erate physical contact except during reproduction

Special attention is devoted to the problem of food and the necessity of providing a reasonably varied diet, together with the timing and method of food presentation Another section is devoted to breeding, and details are given of the author's method of breeding hares by the use of a double cage whereby the animals are changed over every two days, thus ensuring that their quarters are kept thoroughly clean This is necessary since young hares are particularly susceptible to coccidiosis and become reinfected if they remain in one place for more than two days The relationship of animals with man forms the subject of an interesting chapter in which the question of the training of animals is discussed , this is considered by the author to correspond in some respects with sport and athletics in man

Dr Hediger's book will be invaluable to all interested in the proper care of animals in captivity and their behaviour Edward Hindle

## RETINAL RESPONSE

### Optique physiologique

Tome 2 Lumière et couleurs Par Prof Yves Le Grand Pp 490 (Paris Éditions de la *Revue d'optique théorique et instrumentale,* 1949 ) 1600 francs

THE first volume of Prof Y Le Grand's treatise on physiological optics dealt with the eye as an optical instrument , the eye as a receptor of radiant energy forms the theme of this second volume The subject-matter includes the appreciation of brightness and colour, the spectral luminosity functions, colour-matching and the principles of colorimetry, brightness and colour thresholds, visual adaptation, the photochemistry and electrophysiology of the retina, theories of colour vision and colour anomalies —the whole being treated from the physicist's point of view, that is to say, attention being concentrated on results and conceptions expressible in quantitative terms

The author's aim has been to produce a book which, while contributing to the subject, should also have instructional value He has, in fact, included a number of problems (with their solutions) which bring out further implications or applications of the principles discussed This feature is of a piece with the critical approach to the subject, which is in evidence throughout—and how much the more speculative developments of this subject need a critical approach The result, in my opinion, is an account of the highest excellence—lucid, sound, terse, with an occasional half-humorous, half-sardonic comment to provide a touch of seasoning Prof Le Grand appears to have no particular theoretical axe to grind, and his analysis of current theoretical trends, while perhaps unlikely to satisfy completely the respective protagonists, should prove invaluable to the student

In a very few places conclusions are reported which are no longer accepted, for example, the estimate of ten chromophore groups to a visual purple molecule (p 366) But my main complaint—a minor one—concerns the references , although some 160 of these are listed in full at the end of the book, there are many more in the text identified only by a name and year It would be helpful if the full references, at least for the more recent papers, could be given in a future edition, or perhaps as an addendum to the third volume which Prof Le Grand has promised us

W S Stiles

## The Electronic Engineering Master Index

A Subject Index to the Contents of Electronic and Allied Engineering Publications printed throughout the World from January 1947 through December 1948 Pp xiii+339 (New York · Electronics Research Publishing Co , Inc., 1950 ) 19 50 dollars

THIS book is the third of a series covering electronic and allied engineering literature published throughout the world from 1925 onwards It contains a cumulative index by means of which all entries pertaining to a given subject, whether they appear in this or in the earlier volumes, may be rapidly located The present volume contains more than 18,000 entries taken from 230 major publications issued during 1947 and 1948, including 5,500 electronic and allied patents issued by the United States Patent Office In addition, there is a bibliography of engineering books, but this is limited almost entirely to books published in the United States, although the editor expresses the hope that subsequent editions will include the books of all the technical publishers of the world

The system employed in the "Master Index" is the simple one of classification in alphabetical order of main subject headings with sub-headings where necessary, for example, "ACOUSTICS" is followed by "ACOUSTICS, Electrical Analogies", "ACOUSTICS, Electroacoustics", "ACOUSTICS, Hearing", etc As one would expect, with such a system a given entry may appear more than once Thus, some of the entries under "AIRCRAFT Direction Finders" also appear under "DIRECTION FINDERS" Those entries which do not so appear seem to be of lesser importance, but in any event they are readily found if the user first consults the cumulative subject index, where he finds the numbers of all pages on which appear entries relating to direction finders In some cases the classification may be a little surprising; thus articles on diversity reception are listed under the heading "RECEPTION, Selectivity", but again use of the cumulative subject index ensures that the references are not missed Cross-referencing is not dictated solely by the wording of the title, thus, an article entitled "Dipole with unbalanced feeder" appears under "ANTENNAS", and also under "TELEVISION, Antennas", since, as reference to the article shows, it is concerned with a form of antenna commonly used for television reception

The book should be of great value to workers in the electronic field, and particularly to documentation units and patents departments

## Boron Trifluoride and its Derivatives

By Prof Harold Simmons Booth and Prof Donald Ray Martin Pp ix+315 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 40*s* net

THE chemistry of boron trifluoride has progressed rapidly during the past twelve years, and a monograph on this subject is very timely

The preparation, analysis, physical and general chemical properties of boron trifluoride and the fluoroborates are dealt with concisely and adequately The key sections of a book on boron trifluoride must, however, be those dealing with its use as a co-ordinating agent and in catalysis, and it is this part which is most open to criticism. While it is clear that the authors have covered the literature in detail, they make little attempt to present a critical, balanced and correlated account of the vast amount of published work, good, bad and indifferent The m value of the monograph thus lies in the bibliogra of almost a thousand references going up to Janu 1948 , the patent literature, in particular, has b thoroughly surveyed and indexed The majority the errors in the monograph are small and obvio it is to be hoped, however, that a later edition include the evidence which refutes claims to h prepared compounds of argon and boron trifluor

Merely by reading this book, one can see m topics for fundamental research on the chemistry co-ordination compounds, and for the further us boron trifluoride as a catalyst The task of collec all the relevant data can have been no easy one, the authors are to be congratulated on producin book which, if not stimulating, is thought-provok and invaluable to those interested in co-ordinat or catalysis.

R N HASZELDIN

## An Introduction to Electronics

By J Yarwood Pp ix+329 (London Chapn and Hall, Ltd , 1950 ) 28*s* net

THIS book was primarily written for use physics and engineering students, either p graduate or at the universities, who are findin knowledge of electronics of increasing importance their work and in preparing for their final exami tions It does not pretend to contain original w but the author has succeeded in presenting his sub in a very lucid and logical manner, so that the b can be read with interest not only by students also by all new workers in the electronics field

In the preparation of his subject-matter, Mr Yarwood has successfully drawn on his experience a lecturer on this subject to technical college stude He has treated the subject from a physicist's rat than from an engineer's point of view, and has b careful to avoid getting involved in detailed desc tions of engineering applications of the principles t in general he so admirably describes The first chapters on basic electronic theory, including fun mental electricity and magnetism and alternat current theory and the emission and motion electrons, form an excellent introduction to operation of thermionic valves and their uses amplifiers, oscillators and modulators Other chapt describe the operation of photo-electric and catho ray tubes, electron optics and the electron microsco and the operation of ultra-high-frequency devi including the magnetron and the klystron

A chapter on contact rectifiers and amplifiers wo be a useful addition, but otherwise the book is a v good "Introduction to Electronics".

L E RYAL

## Insect Life

By Arthur Smith (Puffin Picture Book 66 ) Pp. (Harmondsworth Penguin Books, Ltd , 1950 )

SOONER or later it was inevitable that one of popular Puffin books for children should d with insect life. This has been prepared by Art Smith and maintains the generally high standard its predecessors The treatment of each insect family of insects usually begins by consideration its better-known characteristics—the chirping of grasshopper, the long proboscis of the hazel- weevil, the 'cuckoo spit' of the frog-hopper—a details of life-history and anatomy are given af the young reader's attention has been caught Nea every example chosen is beautifully illustrated photogravure and can scarcely fail to capture t interest of anyone who opens the book

# FIFTY YEARS AT THE ROYAL INSTITUTION*

By RALPH CORY

Librarian of the Institution

FOR one of the staff—one of the "working staff" as Sir James Dewar used to call us—to be asked to give a Friday Evening Discourse is, I think, quite without precedent and I am very conscious of the honour the Managers have conferred on me in inviting me to give a talk about my fifty years in the service of the Royal Institution

According to tradition, on one occasion many years ago, a Friday Evening lecturer had a sudden attack of stage fright at the last moment and, being unattended, fled. Fortunately, Faraday was present and stepped into the breach So that there should be no recurrence of a similar catastrophe, every Friday evening someone waits outside with the lecturer to ensure that he enters this theatre as the clock strikes For many years that has been one of my duties, but to-night the position has been reversed and I have been the guarded one. I can assure you I have every sympathy with Wheatstone, the one that ran away

The fifty years of which I am to speak began on a dull February afternoon in 1899 when I turned into Albemarle Street for the first time in search of the Royal Institution, then totally unknown to me Outwardly the building appeared very much as it does to-day, the street perhaps was a little different, with gas lamps and cobble paving; of course, all vehicles were horse-drawn, and for some years after I came the lecture syllabus bore a request that "Coachmen may be ordered to set down with their horses' heads towards Piccadilly and to take up towards Grafton Street" But if the Institution has not changed, many of its neighbours have—or even completely disappeared, as in the case of St George's Chapel Brown's Hotel, however, is unchanged, and n this connexion I would like to jump forward a few years for a moment to the early days of the Second World War The British Council proposed to produce a documentary film for circulation abroad which was called "Men of Science" It told the story of Davy and Faraday, and the Managers of the Institution allowed the relevant scenes to be shot in the Theatre and the Library Incidentally, the script described Faraday's first meeting with Davy and it was proposed to show Faraday coming to the Institution in response to Davy's letter This occurred in 1813, and when the producer learnt that the Corinthian columns outside the Institution—copied from the Temple of Antonio in Rome—were only added by he architect Vulliamy in 1838, it was decided that Brown's Hotel probably most closely resembled the original exterior of the Royal Institution, so one morning, with police holding up the traffic, an excited Faraday, played by Walter Hudd, dashed into the Hotel, with Davy's letter prominently displayed in his hand Other scenes showed Faraday bringing his wife (played by Nova Pilbeam) into the Library and of both Davy and Faraday lecturing, and also the Wheatstone incident It was a strange week in the life of the usually sedate Institution, but not without its interest and excitements

But to go back to 1899 I had answered an adverisement in *The Times* for an "Assistant in the Office", and getting no reply was advised to call To a callow nervous youth the Institution looked rather awe-inspiring, and I well remember it was with some trepidation that I pushed open the swing doors and entered this building for the first time In the old entrance hall Brewster, the hall porter, sat by the foot of the stairs He had a bushy black beard and for uniform wore an evening dress coat with large brass Royal Institution buttons I asked a little nervously if I could see the "Assistant Secretary"—I did not know his name then Fortunately he would see me, and I was shown into the office and I had my first meeting with Mr Young The upshot of that short interview was my engagement as "Assistant-in-the-Office" at a salary of 15*s* a week paid monthly by cheque

Many of you will remember Mr Young—quiet, reserved and rather shy, we always worked together in perfect harmony, probably due more to his tolerance and patience rather than to my efficiency Like Faraday, he was a Sandemanian in religious belief, and I believe he spent his holidays preaching for country ministers Young told me that he was probably the last link in the Institution with Faraday, and while he could not honestly say he knew Faraday, he must have seen him, because he was a frequent visitor to his home, although at the time Young was too small to remember him

Before I go on to speak of people and events, I should like to run through the rooms and libraries of the Institution as they were when I first knew them. The Newspaper Room was not quite so comfortable as it is to-day The Library was much more severe than the present room, although the furniture is much the same The two tunnel-like doors at the end led into the Long Library and Writing Room, they were cut through in 1896 when Dr Mond founded the Davy Faraday Research Laboratory and gave these two rooms as an extension of the Library The Library lighting was crude but efficient —the casing on the ceiling is not all wired, much of it being added for the sake of symmetry When a few years later a semi-indirect system was installed, to avoid damaging the ceiling, the casing and ceiling roses were not removed, this led an American visitor to comment to me on the curious but striking decoration of the ceiling The Ante-room was a little smaller than the present one On the first floor also are the two new libraries I have already referred to The Long Library was furnished with five large tables, and when later I was appointed assistant in the Library I had to fill these with exhibits each Friday evening On the occasion of the first centenary, an exhibition of the historic apparatus of Davy and Faraday was arranged in these Libraries, and at the close of the exhibition it was decided to keep the apparatus on permanent exhibition in cases mounted on the mantelpieces The big Spottiswood induction coil which gave a spark of eighty-two inches in air, piercing plate-glass three inches thick, was also here This coil is now in the Science Museum The Writing Room has changed but little, additional shelves only have been erected on either side of the doorway In 1899 the Managers Room was at the extreme north end of the building, where the present emergency staircase leads to the street It was a long narrow room with only one window There was a second door which led to the Model Room Above this door was a prominent reminder—which the Chairman could not fail to see from his seat—of the date when the renewal fines for the Conduit Mead leases were due, if notice of the Institution's intention to renew any of these leases was not given on the due date they were liable to lapse The Rumford stove, surmounted by a bust of Faraday, was a curious fixture When once the fire was alight, the stove functioned very efficiently, but the porters found it very tricky to start The flue ran diagonally behind the books and at the lower corner there was a movable iron trap I have frequently seen the porter Halford soak a handful of cotton waste with methylated spirits, remove the trap, light and throw in the flaming waste, thus creating a draught and inducing the fire to burn—a risky proceeding perhaps, but certainly effective I cannot help feeling that it was unfortunate that this stove was not preserved at the time of the rebuilding, as it was an interesting relic

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* Substance of a Friday Evening Discourse at the Royal Institution n November 17

June of 1899 was the first centenary of the Institution and, new-comer as I was, I was at once plunged into the preparations for its celebrations under the dynamic personality of Prof J Dewar, as he was then, so there was no time for slacking The first commemorative lecture was given by Lord Rayleigh, at which the Prince of Wales took the chair. Dewar gave the second lecture, which was very fully illustrated by experiments

This would seem a good point for me to say a little more about Dewar, under whom I served for nearly twenty-five years At that time he worked principally in the then "New" Laboratory This led off the older Chemical Laboratory which, when I first saw it, was not what I had always imagined a chemical laboratory to be The gas engines and compressors of the liquefaction plant gave it far more the appearance of an engine room The complicated and enormous machinery were in striking contrast to the compact apparatus which will do the same work to-day The New Laboratory was added in 1896 by Dr Mond when he endowed the Davy Faraday Laboratory It is now occupied by the workshop Dewar's principal assistant was a brother Scot, Robert N Lennox, who was an engineer and was largely responsible for the design of the compressors and liquefaction plant His colleague and Dewar's second assistant was Mr Heath, who was also responsible for the lecture demonstrations. He was succeeded on his retirement by Mr Green, who retired only recently It is a tragic coincidence that both Lennox and Heath lost an eye through explosions in the Laboratory

Dewar has been variously described by his biographers, and he certainly was inclined to be irascible and excitable, but he had a magnetic personality and there was a something about him which far outweighed his frequent petulant outbursts His one over-riding obsession was the Royal Institution, and for him it mattered not who or what went to the wall so long as his beloved Institution survived. I always found him very ready to listen to any reasonable argument, but he would not tolerate the slightest familiarity When he received his knighthood, on meeting him in the Library I congratulated him as "Sir James" and was promptly told, "Not so much of the Sir, Cory" Incidentally, I was given a crisp £5 note—enormous largesse in those days—with which to celebrate his honour in due and fitting manner Dewar had a habit of humming—more or less tunefully—as he went about the building, which gave the staff ample warning of his approach Promptly every morning at half past ten we would hear the door shut and then his humming growing gradually lower as he came downstairs His first visit was invariably to the office to discuss with Young any correspondence and affairs generally. Dewar certainly kept a finger on the pulse of the Institution and knew exactly what was happening in every department

Dr Ludwig Mond, the founder of the Davy Faraday Laboratory, was a great personal friend and frequently visited Dewar He was a generous benefactor, and Dewar never appealed to him in vain Mond found the stairs up to the flat rather trying and he paid for the installation of our first lift He would not trust a suspended lift, and so a shaft had to be sunk to the same depth as the height to the second floor in order to take the ram I remember later there was some complaint about the lift which the company disputed, and a representative called to see Dewar about it Dewar came down and greeted him very cheerily "Good morning—sit down, sit down" I retired discreetly through the sliding door and soon I heard Dewar's voice getting louder and louder and his fist hammering out his points on the desk A few moments later a very subdued engineer emerged, and when the man had gone, Sir James turned to me and said "Cory, I've told that gentleman something—I'm not sure it wouldn't be actionable" But at any rate we got what we wanted.

The outbreak of the First World War made it difficult to carry on the engineering work involved in the low-temperature investigations, and Dewar turned, as he said—"to something cheap—soap" His big bubble lasted many weeks It was kept in the basement, and last thing each night Dewar would go down to take the readings He told me how the little Institution cat would sit on the top of the step ladder and watch, fascinated by the changing colours of the bubble Unfortunately the cat was killed in a lift accident, much to Dewar's grief

No doubt Dewar was a very active personality. Passing through the library one day he found a Dr Forbes sitting there reading "Hullo, Forbes, how are you ?" he said "Oh", said Dr Forbes, "as well as I can expect to be at my age" "At your age", said Dewar, "how old are you ?" "Well, I'll soon be seventy", said Forbes "Seventy", said Dewar, giving him a slap on the back that nearly made him collapse "You're only a boy Look at me—I'm eighty" And he went out humming an indistinguishable air

I am glad that my last recollections of Dewar are happy ones Just before Easter in 1923, Young was ill and I was doing the office work As I was leaving one evening the hall porter handed me a telegram from Prof H A Lorentz, of Leyden, raising some query about a Discourse he was to give later in the year My first impulse was to put it in my pocket, but on second thoughts it occurred to me that if I left it until morning, Dewar would say, "Why wasn't I shown this last night ?" So I went upstairs and found him in the drawing room in front of the fire—it was a cold March evening—with Lady Dewar, a tea table between them I showed him the wire and he immediately began to dictate a reply—but broke off and said, "No, it's getting late—we can't do anything about it to-night, see me in the morning—get along home—good night" I did not see him alive again He worked in the laboratory later that evening and in the early hours of the following morning had a stroke from which he never recovered

The staff paid their last tribute to him at a simple funeral service in his study, conducted by his old friend Canon Carnegie

Sir James Dewar was succeeded as resident professor by Sir William Bragg, under whose direction the Institution became even more popular The twenty years or so when I served here under Sir William Bragg were, I think, the happiest of all, and I know that every member of the staff here would cheerfully give of his best for him

My memory is a little vague as to which was actually the first Friday evening I attended, but I do remember Young telling me that if I had evening clothes I should wear them, but he added, "Don't make yourself too conspicuous" My feelings that first evening may be imagined, but I survived

The assistant librarian in 1899 was Herbert Fyfe, a young brother of Sir Hamilton Fyfe—and I used to relieve him in the Library and in this way got some insight into its working When Fyfe resigned in 1902 to take up journalism, Young told me that when the Managers expressed the opinion that I was rather young for the post, he had pointed out to them that I would know more about the Library than a newcomer, and they agreed to give me three months trial as assistant in the Library

Now a word or two about what Dewar used to call the "working staff" He drew up an elaborate code of rules for this "working staff", which all had to sign If, however, anyone was guilty of an offence which was apparently not covered by the rules—as occasionally happened—the rules were promptly altered to meet the case, and we all had to sign the fresh code I do not know how many I signed at different times

I have already mentioned Brewster, the hall porter There were two other porters Halford, who succeeded Brewster as hall porter and who will be remembered by many to-day, and Lloyd, with the long patriarchal white beard He was the resident porter and slept on the little truckle bed in the office. Richard Fowler was the house carpenter Dick was a great character, completely absorbed in the Royal Institution, and it was generally believed that he knew every brick and the run of every pipe and wire in the building He was gruff in manner at first but one soon got used to him It was quite entertaining to hear him in an argument with Dewar, and he usually came off best

The honorary secretary in 1899 was Sir Frederick Bramwell, a civil engineer and a jovial and typical Victorian A bust of him by Onslow Ford was presented to the Institution by the Managers and some friends in 1902 It stands in the old Entrance Hall, and if you will look closely you will see that the right eyebrow is, as Sir Frederick put it, "cocked up". At the meeting at which the bust was presented, Sir Frederick said that he criticized this feature to the sculptor, who only referred him to a looking-glass, and, said Sir Frederick, "when I looked more closely in the glass I found to my surprise that Ford was right" Bramwell retired in 1900 and was succeeded by Sir William Crookes, who was an excellent secretary

For twenty-five years of my service the treasurer was Sir James Crichton Browne, one of the outstanding personalities of the period When I congratulated Sir James on his ninety-fifth birthday he said "This morning the *Evening Standard* rang up, but you know I'm rather deaf and my wife answered, and said the newspaper would like my impressions of old age. I told Lady Crichton Browne to say to the *Evening Standard* that I hadn't any—I'd never experienced it". And truly, increasing deafness seemed to be the only evidence of approaching old age I remember at the end of a general meeting, when members have the opportunity of raising any matter they wish, one member stood up and made some criticism or complaint Sir James, who was in the chair, listened courteously and gravely, and when the member sat down he said "Thank you—the Managers will consider what you have said", and then later, as the meeting closed, he turned to Young who was sitting beside him and whispered, "What did he say, Young ?" On another occasion when I was in the office, Sir James Crichton Browne, who had been upstairs with Dewar, came into the office and said, "You know, Cory, Sir James is getting old and I have to watch his actions very closely" He was followed some time later by Dewar, who made an almost identical remark about the other "Sir James" Crichton Browne was a most faithful attendant at the Friday evening meetings and was most frequently in the chair Although deaf, he would sit through the lecture almost without moving in just the attitude depicted in the picture in the Ante-room of a Friday Evening Discourse

I have known many Fullerian professors of physiology, who only hold office for three years, and some of them stand out in my memory The first I knew was Sir Ray Lankester—not unlike Dewar in disposition, but I think more surly In addition to lantern slides he used to illustrate his lectures with numerous large diagrams He would make Halford cover the Ante-room floor with them and give directions how he wanted them hung on the baize curtains on each side of the screen When he wanted to refer to them in his lecture he would say suddenly, "Give me the stick" We had no optical pointer in those days and the long pointer would be handed to him When he had made his point the 'stick' would be waved about, seeking some place to put it down, to the danger of the eyes of the occupants of the front row—and Halford would dash forward to retrieve it Prof Stirling, of Manchester, was another character tall—immaculately dressed—frock coat and flowing black bow tie and 'pince-nez' on a narrow black ribbon He would frequently send Young a post-card on the morning of his lectures, with a list of live-stock—rabbits and rats, etc —which he wanted to illustrate his lecture in the afternoon Halford was usually sent off to search the Seven Dials where, then as now, many animal shops were to be found The rabbits often did not survive the lecture, and made the main dish for the porter's dinner on the following day Stirling made a practice of keeping all his slides until the end of his lecture, when he would run through them, describing each one His timing was amazing, and he invariably brought down the pointer from the last slide as the clock struck

You are all, of course, very familiar with the famous Christmas Lectures adapted to their "Juvenile Auditory" I remember that I was very much impressed by the first course I heard at Christmas 1899, namely, "Fluids in Motion and at Rest", by C V Boys Those who knew him will realize that the lectures did not suffer from the lack of demonstrations Astronomy is perhaps one of the most difficult subjects to illustrate by experiments, certainly more so than physics or chemistry, but lecturers like Sir Robert Ball and Prof H H Turner always succeeded in making the subject most attractive Turner delivered several courses of Juvenile Lectures, and in one of them he proposed to illustrate the discovery of the planet Neptune by Le Verrier by means of a short play Dewar was very much opposed to the idea as being too theatrical, but Turner was insistent He chose his cast from children in his audience at the first lecture and rehearsed them in the Library in the short play he had written. At the lecture the story was thus told in dramatic form by the young actors all in costume and it was a great success

For two courses this lecture room has become almost a zoo in miniature Sir Peter Chalmers Mitchell, when secretary of the Zoological Society of London, lectured on the "Childhood of Animals", and many young animals were lent by the Zoo as exhibits I remember specially his pet jaguar, which was brought to the Institution in a laundry basket He was a friendly cub and was given a dish of milk on the lecture table, which was lapped up quietly in marked contrast to the snarls and growls with which he tackled a piece of raw meat which followed, the taste of blood arousing all his savage instincts

In 1936 Prof Julian Huxley, who succeeded Chalmers Mitchell at the Zoo, had a lion cub brought from the Gardens for one of his lectures While waiting for his turn to appear, young Leo was confined in the lift lobby off the long library. He did not approve of these quarters, and when the keeper went to fetch him his temper was distinctly frayed and the keeper had considerable difficulty in piloting him along the corridor to the Theatre However, he soon settled down and after the lecture allowed himself to be petted, but the keeper kept on the alert in the background

Another juvenile lecturer with a sense of the dramatic was Prof James Kendall, who gave a course on "Young Chemists and Great Discoveries" He delivered the latter part of the lecture on Faraday realistically made up and dressed to impersonate the famous scientist, and the result was remarkably good In this guise he recited parts of Faraday's famous lecture on the "Chemical History of a Candle"

I have, of course, listened to many Friday Evening Discourses, some of which were above my head, but there are one or two which stand out in my memory. Sir Squire Bancroft was a very tall man On the morning of the Friday of his Discourse he called at the Institution, complete with eye-glass, frock coat and top hat He was taken round the Library and also shown the lecture room and desk Sir Squire found the desk too low and asked if it could be raised The blocks which we still use, however, did not meet with his approval He looked at them critically, then waved them away, thought a moment and then, "No, no, let me have some of those musty tomes I've just seen in the Library" So I had to provide two or three thick eighteenth-century folios, on which the desk was raised to a convenient height

In 1900, during Prof J A Ewing's discourse on the metals, about half-way through there came drifting into the theatre the sound of cheering, bells and whistles I remember distinctly the quite perceptible movement among the audience and an audible sigh of relief—Mafeking had been relieved. Nobody stayed long after the lecture that evening

Korea is in the news, and in 1904 we had a discourse on this troubled country by an ecclesiastical dignitary, the Right Honourable and Right Reverend the Count Vay de Vaya and Luskod He created a distinct sensation by appearing in the lecture room arrayed in his gorgeous episcopal robes of scarlet and purple I can still remember Dewar's face when he first saw the vision, and for once he was at a loss for words The discourse was just as picturesque

Imperial defence is a subject perhaps a little removed from the objects of the Royal Institution but the Theatre was crowded out to hear Lord Roberts talk about it in 1906 and utter his words of warning of the German menace, so soon to be fulfilled A few years later Captain Scott spoke of his fears for his forthcoming Antarctic expedition, from which he was never to return

The earliest experiments in radio and the development of the thermionic valve were also described here, by Marconi and Fleming At one of his discourses Marconi was accompanied by his beautiful bride-to-be—the news somehow leaked out and the theatre was packed, but I have a suspicion that the feminine part of the audience were more interested in the lady than in radio

When I was first appointed to the Library, we had an MS catalogue in two folio volumes I had not been assistant librarian very long before, with Mr Young we started a shelf-by-shelf check of the Library and made out slips for every book From these slips the present card catalogue was afterwards prepared and replaced the cumbersome two-volume MS catalogue The actual work of writing and arranging the cards was not started until after the outbreak of the First World War and I had been given leave to rejoin my Territorial regiment, so that I actually did not have any part in the work If I had, I like to think that little slips like entering Savage Landor's book, "Gems of the East", under "Jewellery" would not have occurred, the book, of course, deals with the Philippines

Dr Rushton Parker was, I think, the most voracious reader we ever had He was a retired medical man from Kendal, a bachelor, and was in his armchair promptly at the same time every morning with amazing regularity, and he stayed reading until 10 30 each evening His reading ran in cycles—he would have a spell of archæology, then switch perhaps to natural history, to be followed later by biography and so on From the librarian's point of view he had a very reprehensible habit of making pencil notes and corrections in the books he read These were generally very useful and well justified He would send a list to the author suggesting their incorporation in a second edition and usually received an appreciative acknowledgment One day a member, a barrister, came to me in considerable indignation with our copy of Trevelyan's "History of England" which had been so annotated by Dr Parker He was very irate, and to pacify him I said that on the first opportunity I would go through the book with a rubber and erase the offending notes "Yes, yes," he said, "but please wait until I have copied them into my copy "

Another member, interested in mathematics, found any noise, knocking or hammering, etc, very disturbing One Saturday afternoon he was reading in the Library when hammering started near by—he retreated to the Long Library but it was still audible, so he took a chair into the lift lobby and shut the door In those days the door to this lobby had a spring lock which could only be operated from outside, and when he wanted to leave he found he was locked in About six o'clock, Halford, the porter on duty, going round the Library and not seeing the member anywhere, wondered where he was, and hearing heavy breathing from the lobby opened the door, when a very dishevelled member almost fell on him, muttering, "Thank God you've come". In his endeavours to attract attention he had smashed the large plate glass window and the lift lights and hammered the door with the chair. He was completely exhausted when he was found. The lock was altered after that.

The organization of the exhibits in the Library on Friday evenings has been one of my duties, and in the early days, when I had to fill eight large tables in the three libraries, the task was frequently a problem, but we have somehow managed to get a show of some sort each evening. We have had one or two scares. One morning a diamond was missing. I recall how anxiously the porter and I got down on hands and knees and went over every inch of the carpet, and were rewarded by finding the missing jewel embedded in the pile. On another night, a blue post office Mauritius stamp had been used to demonstrate how the ultra-violet light would reveal that this one had had a corner repaired. It was, however, still very valuable, and it disappeared. I thought it was gone for good, but a few weeks later a member—a very regular attendant—wrote to me, enclosing the missing stamp which he had picked up in a post-card folder with other circulars. When tidying his desk he came across it and promptly returned it.

During the Juvenile Lectures in 1927, soon after the children had left after one of the lectures, there was an electrical explosion in the street, all our windows were blown in, the ceiling of Faraday's laboratory damaged and the vault outside set on fire. The seriousness and the risk of panic, had the explosion occurred during a lecture or as the children were leaving, convinced the Managers of the urgency of improving the exits and the question of security from fire. As a result, complete rebuilding of the northern half of the Institution was decided on and this was begun in 1929.

The present Lecture Theatre was completed in time for the celebrations (in 1931) of the centenary of Faraday's discovery of electromagnetic induction. The celebrations were organized on a scale which made the 1899 centenary seem a very small affair. Many will remember the reception of the foreign delegates at the Institution, the commemorative meeting at the Queen's Hall, followed by the special concert by the Symphony Orchestra under its conductor, Sir Henry Wood, who was a member of the Institution. There was also an evening conversazione at the Institution, with lectures by Sir William Bragg on Faraday's researches, and an exhibition in the Albert Hall of Faraday's original apparatus and demonstrations of the many industries that have grown up from his discovery.

The Second World War found me on holiday in Jersey; Mr. T. Martin, general secretary, who was on the reserve of officers, was called back to the Royal Artillery immediately, being sent later to the Instrument Production Department of the Ministry of Supply. I returned from Jersey as soon as possible, crossing on the Tuesday after the outbreak of war. In the absence of Mr. Martin, I was made deputy general secretary and, since my assistant librarian, Mr. Griffin, was also in the Army, I was left to hold the fort. The basement was made a public air-raid shelter under the Westminster City Council, and it can be imagined how Sir William Bragg and I had to cope with forms and returns. For fire-watching duties we collaborated with the Bond Street Association, and the Institution was a fire-watching post for the block and was manned nightly. A very well equipped first-aid room was organized in the photographic dark-room by Miss Deighton, Sir William Bragg's private secretary; but fortunately she had no serious cases. Although bombs fell unpleasantly near on several occasions, luckily we escaped any serious structural damage, but, of course, our windows suffered severely. Sir William Bragg took a great personal interest in eighty to ninety shelterers each night and was very popular with them.

By Sir William's death in 1942 the Institution suffered a very serious and grievous loss. He was succeeded by Sir Henry Dale. When the 'doodlebugs' were being showered on London, one Sunday morning Lansdowne House in Berkeley Square got a direct hit. The effect of the blast on our windows was disastrous, not only glass but also wooden frames being smashed. Sir Henry Dale telephoned to me and I at once came up to town. It was a cold, rainy day and we were much concerned about the books on the window shelves in the Library being exposed to the rain. However, Sir Henry and I took our coats off and, helped by my daughter who had come up with me, we managed to move some hundreds of books away until first-aid repairs to the windows made it possible to replace them.

Now my fifty years have nearly run to fifty-two. Time will not allow me to recall all the famous men I have met—professors, lecturers and members. It must suffice to say that I have seen five presidents, two Dukes of Northumberland, Lord Eustace Percy, Lord Rayleigh and our president to-day, Lord Brabazon—and have served under five directors—Sir James Dewar, Sir William Bragg, Sir Henry Dale, Prof. E. K. Rideal and for the past year under Prof. E. N. da C. Andrade.

## THE GRANITIC LAYER OF THE EARTH'S CRUST

THERE has long been a widespread belief that the outer crust of the earth consists of a layer of basalt overlying ultrabasic material and that the continents are slabs of granite, floating in the denser underlying rocks. Recently, this view has been challenged on both geological and geophysical grounds, so that a lively discussion was to be expected when the subject was debated at a meeting held in the rooms of the Royal Astronomical Society on October 27. Prof. O. T. Jones was in the chair, and introduced Dr. E. C. Bullard, Prof. H. H. Read, Dr. R. Stoneley and Dr. P. L. Willmore as the principal speakers.

Dr. Bullard began by discussing the seismological observations, which show that *P*-waves observed at short distances from shallow disturbances are propagated with a velocity of 5.6–6.5 km./sec. At distances exceeding 150 km. the velocities observed are in the range of $8.1 \pm 0.15$ km./sec. These results indicate a change of physical properties at a depth of some 30–40 km.; but it is doubtful whether there is an abrupt discontinuity, or some more gradual transition. Evidently, however, the lower layer is much more uniform than the rocks which appear at the surface. In discussing whether the range of 5.6–6.5 km./sec.

represents a layered structure or random variations within the upper regions of the crust, Dr Bullard remarked that seismologists, perhaps by false analogy with the mesozoic structures on which their universities are so often constructed, have usually tended to favour the former alternative This outlook, which requires that the seismic onsets should fit on to a set of linear travel-time curves, was excusable when any one earthquake provided only a few seismograms, but it produced a dangerous tendency for later workers to bias their readings in favour of preconceived ideas Thus, continued Dr Bullard, in the case of the Heligoland explosion, Willmore completed the reading of his records before attempting any interpretation, while an American group "searched the literature" before seeking confirmation on the seismograms Willmore found that little significance could be attached to anything other than the first onsets The Americans found almost exact correspondence with a multiple-layer hypothesis, but as their data had evidently been subjected to a most drastic process of selection, Dr Bullard did not believe in their conclusions In Europe, America and South Africa the seismological evidence for an intermediate layer is still quite inconclusive

On the petrological side, it has been found that rocks of a most varied kind occur under the sediments The commonest material is probably gneiss with a composition similar to that of granite. The structures of an exposed basement complex are often ten or more kilometres across, and it would be incredible for such features to exist in a thin skin, covering a homogeneous granitic layer Gravity observations confirm that the surface variations must extend over most of the thickness of the crust, and it is probable that the basement rocks represent the 'roots' of worn-down mountain ranges Under the oceans, seismic refraction shooting reveals higher velocities than on continents, and the granitic layer is probably absent

Prof Read stated that if a 'granitic layer' exists it must underlie the rocks described by Bullard The geological evidence for its existence is only that the proportion of granite generally increases with depth. Among geologists, there is a survival of the idea that, in exposed shields, we see the primeval crust This hypothesis is most nearly consistent with the petrology of the Brazilian shield, but remains of sediments can be found even there If there is a primordial granitic layer, it is necessary to explain how it could separate from a basaltic magma If not, one has to assume that early sediments somehow became granitized, and the source of the necessary acidic constituents has then to be explained In this connexion, Rittmann has suggested that the granitized materials have condensed from the early atmosphere On any theory, the collection of the granite into the continents is the outstanding difficulty It has been suggested that the granitic crust was ruptured by the extraction of the moon or by the action of convection currents, but neither of these appears to be satisfactory

Dr Stoneley endorsed most of Dr Bullard's remarks, but thought that seismic refraction work does provide evidence for the existence, at least locally, of an intermediate layer It would, however, be naive to suggest that any such layer is strictly uniform over continental distances For surface waves of the Love type, it is possible to derive a dispersion formula for two layers of arbitrary thickness, in terms of the published velocities of $S$-waves for the upper and intermediate layers Trial solutions are consistent with the relation

$$2T_1 + T_2 = 65\ 5\ \text{km}\,,$$

where $T_1$ and $T_2$ are the thicknesses of the upper and intermediate layers, respectively A second equation can be derived by consideration of reflected pulses from deep-focus earthquakes The equations indicate that $T_2$ does not differ significantly from zero On making the further assumption that the ocean floor is entirely basalt, it is found that isostatic equilibrium is consistent with the idea that the ultrabasic layer extends continuously under both oceans and continents

In criticizing the $P^*$ data from near earthquakes, Dr Willmore said that the estimates by different authors for the properties of the intermediate layer in a given region are sometimes so discordant that the observers cannot have been reading corresponding events on their seismograms Since the Second World War, numerous observations have been obtained from stations close to explosions and tremor sources, so that discussions can now be founded on unmistakable first arrivals In north Germany, the velocities measured over distances between 25 and 50 km from the Soltau explosions do not differ significantly from those observed between 50 and 100 km from Heligoland On the other hand, if all the data are considered in relation to a single travel-time line, there is a tendency for onsets at the shortest and longest distances to be early This is consistent with a general tendency for the velocity to increase downwards, but gravitational and magnetic surveys have revealed crustal irregularities which might have produced a similar effect In South Africa, a similar tendency for waves to arrive early at distances beyond 120 km is associated with the exposure of high-velocity rock in the region where the onsets are observed Later in the discussion Dr Bullard mentioned that unpublished work in America has also revealed early onsets at about 100 km from the source, and it was agreed that the balance of evidence favours a tendency for velocity to increase downwards

Dr Willmore mentioned the fact that most recent determinations of the velocity of $P$-waves within 100 km of the source yield values higher than that of the near-earthquake $P_g$ Wood and Gutenberg have suggested that high-velocity material may cover the low-velocity layer, but it is equally likely for the difference to be instrumental Short-period instruments of the type used in tremor work might be able to detect waves which filter through small bodies of high-velocity rock, while the waves detected by earthquake instruments might travel with a velocity nearer to the bulk average Finally, it has been shown that an average value for the velocity in the crust can be determined by observing the distance at which $P_n$ first appears on the seismograms This average velocity is in the neighbourhood of 6 4 km. per sec in South Africa, so that if a low-velocity layer were present, it would have to be balanced by a greater thickness with a velocity of at least 6 8 km/sec

In the course of the discussion, various speakers quoted figures to show that velocities and densities in the sediments can be as high as those in the granitic layer Prof C E Tilley remarked that basalts do differentiate into granites on cooling, but he could advance no theory to cover the concentration of granite in the continents Prof R M. Shackleton suggested that the down-buckling of geosynclines might be the primary cause of granitization and that the presence of sediments might be incidental Dr G. M Lees challenged the use of such words as 'granitic' and 'ultrabasic' to describe the undetermined material between physical boundaries, and also suggested that there is no evidence for a difference between the materials of the continents and the ocean floor In this he was supported by a reference to the results of seismic shooting at one station in the Atlantic, but Dr Bullard quoted unpublished work which indicates velocities of about 8 km/sec under the Pacific

# OBITUARIES

## Dr. R S. Clark

Born in Aberdeen in 1882 and educated there at the Grammar School and the University (M A, 1908), Robert Selbie Clark had intended to become a schoolmaster, but the influence of Prof J Arthur Thomson in zoology and of Prof J W H Trail in botany made him a biologist (B Sc, 1911) His first post, under Dr W S Bruce in the Scottish Oceanographical Laboratory in Edinburgh, turned his attention to Antarctic marine life in general and particularly to fishes, and these two interests dominated his scientific life

In 1913 Clark was appointed naturalist at Plymouth Marine Laboratory, but in the following year he joined Shackleton's ill-fated Antarctic expedition on the *Endurance* He had many vivid and amusing stories to tell of the hardships suffered after the *Endurance* sank in the Weddell Sea, of the journey on the ice-pack and the months of isolation on Elephant Island, but his great regret was that the marine collections he had amassed so carefully were lost with the ship

From the Antarctic, Clark returned in 1916 to a life scarcely less uncomfortable and hazardous on H M minesweepers during the First World War, and eventually resumed the duties of peace at Plymouth In 1923 he returned to Aberdeen as senior naturalist to the Scottish Fishery Board, and eleven years later succeeded Dr A Bowman as scientific superintendent, a post later converted into the directorship of the Scottish Home Office Marine Laboratory Under his charge, the scientific staff of the Laboratory increased in numbers and engaged in a wide variety of activities linked with the programme of the International Council for the Exploration of the Sea

Clark himself was too critical of his own work to be a prolific writer, but his papers have a permanent value for fishery research His earliest publications describe some of the fishes brought home by the Scottish National Antarctic Expedition, his later work all bore upon British fisheries An examination of thousands of rays and skates resulted in a valuable and much-needed revision of the characters and nomenclature of the European species and their early stages His contributions at meetings of the International Council included papers of importance on the characters and distribution of the larvæ of spring and autumn herring and on the influence of the size of mesh of trawl nets in regulating the escape of under-sized fishes, and his analysis of the independent stocks of haddock in European waters led to the encouraging conclusion that in any year somewhere in the area of haddock distribution a lucrative fishery would be possible.

Clark was a striking personality, an all-round sportsman, who had represented Aberdeenshire, Hampshire and Scotland at cricket and had played Association football as an amateur in the Aberdeen team, and who in maturer years retained his skill as a golfer and an angler His scientific activities did not end with his official retirement in 1948, for since then, at the request of the International Council, he had been chairman of its Northern North Sea Committee, and took an active part in the Edinburgh meeting of the Council in 1949 He died after a short illness on September 29, and is survived by his widow, for whom much sympathy will be felt

James Ritchie

## Mr R H Worth

Richard Hansford Worth, whose death occurred on November 11, was born in Plymouth on November 5, 1868, the son of R N Worth, journalist, geologist, archæologist and historian of Plymouth He was educated at Plymouth High School (now Plymouth College) and lived in his native city all his life A civil engineer by profession, he followed his father in having very wide cultural interests As a geologist he worked on the petrology of Dartmoor and its neighbourhood, and, in co-operation with the Marine Biological Association, contributed to our knowledge of the geology of the English Channel by a study of the rocks dredged from the sea floor He also studied the Foraminifera

In his professional capacity he was interested in hydrology and the water flow of rivers, and for many years was secretary and, later, recorder for the Committee of the Devonshire Association responsible for drawing up the annual statements on the climate of the county It is not possible in the space available to list his many activities, but Hansford Worth will best be remembered as the greatest authority on Dartmoor in all its aspects The scientifically accurate and objective descriptions he made of the antiquities, both prehistoric and historic, will be of lasting value He first began to publish papers on Dartmoor in 1889, and many of his important records are to be found among the pages of the *Transactions of the Devonshire Association,* of which he was a past president He was associated with the Dartmoor Exploration Committee started by Burnard, Baring Gould and R N Worth in 1893 for the excavation of archæological remains, and in 1897 succeeded his father as secretary of the Association's Committee on Barrows, later becoming recorder He issued full descriptions of the sixty-one stone rows, a class of monument in which Dartmoor is particularly rich His evidence that their orientation had no ritual significance but depended upon topographical conditions is definite, and his decision that they afforded no clue as to their function beyond that they were sepulchral monuments with barrows usually at their higher ends was typical of his independent and objective outlook He also issued descriptions of ruins connected with tin mining on the moor, and of many other historic remains and implements

Probably no man has known so much of the topography of Dartmoor and of its history Many lovers of Devonshire will miss his kindly and distinguished presence, and their sympathies will be deep for his widow, who accompanied him on so many excursions to the moor F S Russell

## Mr. A. C. Forbes, O.B.E.

By the death of Mr. A. C. Forbes, forestry circles in Great Britain and in Ireland have lost a good friend and one who was keenly interested in the forest and the work of the forest.

Mr. Forbes attended the University of Edinburgh as an arts student in the year 1890–91; he then left the University and went to Germany, to take forestry courses there. On his return to Britain the possibilities open to him were mainly in estate forestry, and for a time he was forester on the Marquis of Bath's Longleat estate. He became lecturer in forestry in 1904 at the Armstrong College of Science at Newcastle upon Tyne. It was during this period that his first book, "English Estate Forestry", was published (September 1904), and a second edition in 1906. He became director of forestry in Ireland in 1907. During the First World War he was Government controller of timber in Great Britain and was made O.B.E. for his services.

On its inauguration in 1920, Forbes was appointed to the Forestry Commission. It was during this period that he published his later book, "The Development of British Forestry". Perhaps the greatest work carried out by Forbes was that which he did for many private-estate woods in the British Isles. Certainly it was in that work that his heart was wrapped up, for it was work of which he had great knowledge. In his first book (1904) Forbes put on record what may be termed English practice of forestry on the big and small privately owned estates in the country; and this he was enabled to do adequately since he had been a forester in charge of considerable areas. He himself says that the book was intended to be suggestive rather than instructive to the practical forester; but there is a good deal more in its pages than what the practical forester at the beginning of this century was acquainted with. He showed clearly, perhaps for the first time, that both sport and landscape effect could be obtained in conjunction with a sustained annual yield of timber from the woods.

His claim that English estate forestry was sufficiently distinct from Continental or even Scottish forestry to be entitled to regard it as a separate subject has scarcely been maintained. Modifications of the management there may have to be; but these cannot be regarded as entitling the matter to be a separate subject. This being said, there is no doubt that the work of Mr. Forbes had considerable influence in shaping British forestry.

E. P. Stebbing

# NEWS and VIEWS

## Museum of the History of Science, Oxford: Dr. C. Josten

Dr. Conrad Josten has been appointed curator of the Museum of the History of Science at Oxford, in succession to Dr. F. Sherwood Taylor, who has become director of the Science Museum. Dr. Josten studied at the Universities of Geneva, Freiburg i.B. and Bonn, and was awarded the degree of Ll.D. (*Doctor iuris utriusque*) at the University of Erlangen. From the year 1935 he took up the study of ancient scientific instruments, of which he made a considerable collection, and also interested himself in the history of alchemy and early astronomy. During the War his opposition to the Nazi regime necessitated his disappearance; but in 1948 he was able to go to Oxford and to study the Ashmolean MSS. in the Bodleian Library. Dr. Josten first published an unknown alchemical text of Robert Fludd; a critical edition and translation of the early alchemical "Letter of John Dastin to Pope John XXII"; a study of the alchemist, William Backhouse of Swallowfield, the instructor of Elias Ashmole; and during the past two years he has been working on a biography of that remarkable personage. Dr. Josten has succeeded in solving the cipher in which many of Ashmole's notes are written and will be able to show in a new light the founder of the Ashmolean Museum, whose former home is now possessed by the Museum of the History of Science.

## Aeronautical Engineering at Cairo: Prof. E. W. C. Wilkins

E. W. C. Wilkins, who has just been appointed to the chair of aeronautical engineering at Fouad I University, Cairo, joined the staff of the Oxford University Engineering Science Department at the end of 1947. Since then he has taken part in the lecturing and tutoring work of the Department and, in addition, has assisted the professor of engineering science with the financial and administrative work of the Department. Immediately prior to going to Oxford, Prof. Wilkins had spent fourteen years with the Bristol Aeroplane Co., which he joined in 1934 as a technical assistant, becoming, finally, chief airworthiness engineer, his last responsibility in this capacity being the airworthiness of the Brabazon air-liner. Before going to the Bristol Aeroplane Co. he was a lecturer in engineering at London, and before that research engineer with the Ebbw Vale Steel, Iron and Coal Co. while holding an 1851 Exhibition awarded to him in 1928. He has been a member of various aeronautical committees for a number of years, and was latterly chairman of the Royal Aeronautical Society's Detail Design Committee.

## Heinrich Christian Schumacher, 1780–1850

On December 28 the centenary occurs of the death of Heinrich Christian Schumacher, who in 1821 founded the *Astronomische Nachrichten*, which, wrote Grant in 1852, "has perhaps contributed more towards the improvement of astronomical science, in all its branches, than any similar publication has ever done". Born on September 3, 1780, at Bramstedt in Holstein, Schumacher distinguished himself in mathematics and astronomy and after studying at the University of Gottingen took the degree of doctor of law. At the age of thirty he was made a professor extraordinary in the University of Copenhagen, where after a year or two at Mannheim Observatory, he was elected to the chair of astronomy. In 1821, the year he founded the famous periodical, he was appointed director of the newly erected observatory at Altona, where he remained until his death. Among his other activities were the trigonometrical survey of parts of Denmark, the measurement of an arc of the meridian and the determination of the longitude of Altona Observatory. He was also for some time the collaborator with Bessel in the editing of the "Astronomisches Jahrbuch". Both his son Richard Schumacher and his nephew Christian Andreas Schumacher were associated with his work for Denmark.

## Centenary of the Geological Survey of India

THE Geological Survey of India, one of the oldest official organizations of its kind in the world, is due to celebrate in January 1951 the first hundred years of its existence as an organized department. In 1846 the East India Co , on the advice of Sir Henry De la Beche, director-general of the Geological Survey of Great Britain, and of Sir Roderick Murchison, president of the Geological Society of London, appointed D H Williams "to investigate the Coal districts of India" After Williams's death in 1848 there was a partial break in the work, but in 1851, when Thomas Oldham was appointed "Geological Surveyor to the East India Company", the uninterrupted history of the Survey may be said to have begun To commemorate the occasion, the Government of India has arranged a number of events in which representatives of geological surveys and learned societies have been invited to participate The main celebrations will be held in Calcutta during January 10–14, and these will include an exhibition illustrating the history of the Department and the progress of geological discovery in India, and a commemoration ceremony on January 13 This will be followed by a tour to places of geological and mining interest in northern India, concluding at Delhi on January 28 Prior to this, however, the thirty-eighth annual session of the Indian Science Congress, and the first meeting of the Pan Indian Ocean Science Congress (attended by delegates from most of the countries of Gondwanaland), will be held simultaneously in Bangalore during January 2–8, and a number of geologists are expected to attend the Section of Geology and Geography. Further particulars with regard to the centenary celebration programme can be obtained from the Director, Geological Survey of India, 27 Chowringhee, Calcutta 13.

## Forest Economy of Private Estates

IN the Institute Paper No 25 under the heading, "The Forest Economy of Three Private Estates in Great Britain", Mr J J MacGregor, of the Department of Forestry, University of Oxford (I F Institute, University of Oxford, 1949), contrasts the forest economy and management of three differing private estates of which the records of their woods were detailed and covered a sufficiently long period of years to render a comparison possible The usual trouble about private estates in the past has been that though the finances of the agricultural part of the estate as also of the shootings were accurately kept from year to year, little information about the true finance of the woods was available, being often only represented by the total sum obtained when the wood was clear felled As the writer says, "Without further considerable effort it is difficult to co-ordinate odd scraps of financial information about, say, the costs of planting, and about sales of pitwood with the ultimate function of the woodlands on the private estates where they are situated The physical features, the scale and intensity of operations, the capital structure and the extent and variety of the various types of income, the ratio of woodland to agricultural area, and proximity to markets, are all considerations which make one private estate differ economically from another, and also greatly influence the functions of woodlands in the general economy of the estate " A general study of the history of the past appears to show "that since about 1880 estates showed a declining income from farm rents, an increase in taxation burdens and an increase in the cost of upkeep. Although rents might have increased slightly in the period of the First World War, this was more than offset by the increases in the two main expenditure items It is less easy to generalize about the course of income from the woodlands and about other factors." In this brochure Mr MacGregor has produced information which should prove of value to all private estate owners

## Characteristics and Uses of a Mechano-electric Transducer

SINCE its introduction to Great Britain in late 1948, the *RCA*-5734 mechano-electronic transducer has proved itself to be a valuable and versatile research tool. It is a triode-transducer intended to provide a method of translating mechanical into electrical current variations which can be observed and measured The triode has a metal envelope which forms the anode of the valve, and consists of a plate connexion with a thin metal diaphragm at the top, through the centre of which the plate shaft extends. Displacement of the plate shaft changes the distance of the fixed grid from the plate and results in a change of plate current The deflexion sensitivity is 40 volts per degree deflexion of the plate shaft, but the safe limit of deflexion from the normal position is half a degree The part of the plate shaft within the valve has a minimum free cantilever resonance of 12,000 c./s , permitting, with suitable mechanical coupling to the external end of the plate shaft, measurements of vibration up to that frequency The moving element is designed to have very low inertia The transducer may be mounted in any position. It weighs 1 75 gm and is cylindrical of height $1\frac{9}{32}$ in and diameter $\frac{5}{16}$ in

The transducer has applications in many fields. The wide variety of uses to which it may be applied includes gust-recording anemometers for wind-velocity surveys ; oscillograph recording, through a diaphragm attached to the plate shaft, of tank pressures set up during the short-circuit testing of circuit breakers , the direct measurement of arterial and venous blood pressures and the record of pulsations in the arteries , pressure recording through a cardiac catheter in the interior of the human heart , and stress evaluation and vibration phenomena in the motor, aircraft and shipbuilding industries Board of Trade authority for the importation of a small stock of transducers for the benefit of approved institutions has been granted, and colleges, medical schools and research organizations interested should apply to R C A Photophone, Ltd , 36 Woodstock Grove, London, W 12

## Fungicidal Action of Disodium Ethylene *bis*Dithiocarbamate

DISODIUM ethylene *bis*dithiocarbamate (DSE), first synthesized in 1935, gave a rather erratic performance as a fungicide in the field, until Heuberger and Manns found that its performance could be improved by the addition of zinc sulphate and lime Raymond W Barratt and James G Horsfall (Conn Agric Exp Sta Bull 508 , pp 51 , New Haven, U S A , June 1947) conducted a laboratory investigation into the efficiency and mode of action of thirty-six analogues and homologues of the compound, using spores of the fungus *Stemphylium sarcinæforme* for the tests It was concluded, in general, that dithiocarbamate analogues inhibit spores through two reactions by liberating sulphuretted hydrogen, and by forming metal salts of the compound Fungicidal potency seemed to be independent of the number of sulphur atoms in the polysulphide linkage It was found that the addition of zinc sulphate and lime greatly increased the stability of disodium ethylene *bis*dithiocarbamate through the production of zinc ethylene *bis*dithiocarbamate, and this substance is now brought forward as the real fungicide

## Mushroom Research

Some short, useful papers on mushroom pests and diseases are included in two recent numbers of the *M G A. Bulletin*, the organ of the Mushroom Growers' Association, Yaxley, Peterborough A mushroom bed competitor, which is apparently *Corticium centrifugum*, is reported by Fred C Atkins (No 19; April 1950) In No 20 (July 1950), B D Moreton contributes a well-illustrated account of mushroom pests Sciarid, pharid and cecid flies are described, with measures of control, as are springtails, mites and minor pests The roles of *Rhabdites* and *Ditylenchus* eelworms in mushroom beds are also discussed C L Duddington has an interesting short paper, in the same number, on "Fungi that Trap Eelworms". Fifteen species of fungi are known to capture eelworms in sticky networks *Trichothecium flagrans*, *Dactylella ellipsospora* and *D bembicoides* are described and figured in the paper A separate publication on the tray system of growing mushrooms in Great Britain, by Fred C Atkins, is also available from the Association (price 2*s* 6*d*)

## Catalogue of Insecticides and Fungicides

The Murphy Chemical Co, Ltd, Wheathampstead, Herts, has issued an informative catalogue of insecticides and fungicides for the nurseryman and mushroom grower Apart from descriptions of the firm's products, which include a wide range of substances in modern use, short technical information is given on pests, diseases, procedure and materials A separate booklet outlines a complete spraying programme for the control of pests and diseases of mushrooms

## Planets and Sunspots

Dr K G Meldahl has made some supplementary remarks concerning his predictions of sunspots during the early portion of this year (see *Nature*, 165, 301; 1950) Eight drawings on his latest chart ("Tidal Forces in the Sun's Corona due to Planets", Part 2, Copenhagen Berlinske Forlag) show the more important sunspots that he observed from January 18 to March 22, and he has a number of comments to make on these The tidal force in the sun's corona this year was greater and of shorter duration than it was in 1938, and, as the configurations of the two inner planets were different in the two cases, a new field of inquiry appears to be opened up. It is pointed out that when the particles ejected by the sun cross the orbits of Mercury and Venus, if one or more of these planets happen to be in their path, they may suffer a certain amount of dissipation and reach the earth in diminished numbers But if, as happened this year, these planets have moved a little to one side, the field being free from obstructions, the auroras will become more conspicuous, as they did during February of this year These remarks are interesting for all who study sunspots and auroras, and observers of these phenomena may find important work in tracing the correlations between them and the planetary configurations

## Government Spending in Great Britain

In a recent number of *Planning* (PEP, 16 Queen Anne's Gate, London, S W 1, 2*s*) devoted to the subject of government spending, it is pointed out that in the present condition of the British economy there is no lack of claims on any increase of production which may be achieved A continued increase of production, it had been hoped, would progressively relax the stresses of the present, but now greater defence expenditure may hinder the increase of production and will swallow up a part at least of whatever increase is achieved A conflict of interests inevitably arises as between demands for increased personal consumption, greater industrial equipment and the expansion of certain social services To some extent, the decisions must depend on judgment, and where there must be judgment there is room for dispute, there is, however, no point in arguing over matters of ascertainable fact Planning decisions must be based on knowledge of the relevant facts, but at present the planning authorities lack this knowledge The figures on government spending are not available in the most illuminating form; but the official statisticians have not attempted to provide a new classification, probably because of the nature of the records kept by government departments This brochure by PEP suggests that the most practical course might be for the official statisticians to share the work with some of the universities The lead, it is suggested, must come from the Civil Service, since the first step is the remodelling of the systems of accounting and recording in the various government departments.

## *Acta Argentina de Fisiologia y Fisiopatologia*

The work recorded in the first issue of *Acta Argentina de Fisiologia y Fisiopatologia* (1, No 1, pp 291, Córdoba Universidad Nacional, July 1950) covers a wide field Edited by a committee of which Prof A Oriol i Anguera is the director, the journal begins with a paper by A Cardin on the mechanism compensating the postural tone of animals (dogs) from which the cerebellum has been removed, the author claiming that his experiments have revealed two different innervations which influence the postural tone of the limbs, one passing through the cerebellum and the other through the mesencephalon The next four papers record work by L Legresti on the redox potential They deal with its electrometric determination *in vivo* and *in vitro*, the potential in the blood and its reduction by certain substances, the same author contributes, with O E Semino, a further paper on this subject. M C Pérez records his experimental work, with details of his surgical methods, on the production of intestinal occlusion in dogs R D Zunino contributes an article on the vaginal cytology of a human case of sterility, the study of which indicates, he claims, a relation between prolongation of the menstrual cycle and the administration of œstrogen R A Sauchelli discusses renal physiology and pathology in guinea pigs whose ureters or renal arteries or veins have been unilaterally or bilaterally occluded A longer paper by Prof R. A. Brandán considers the climate of the mountains of Córdoba and its effects on certain diseases, and Prof A Oriol i Anguera discusses personality and endocrinology The same author contributes a shorter paper on renal physio-pathology and notes on the Eighteenth International Congress of Physiology, held this year in Copenhagen. The journal is well printed, but the reproduction of its illustrations leaves room for improvement in future issues.

## Library Science Abstracts

THE first issue of a new quarterly journal, *Library Science Abstracts*, edited by Dr C B Muriel Lock and Reginald Northwood Lock (1, No. 1, January–March , pp 36 , London Library Association, 1950 , 15*s* a year), will be a disappointment to the scientific worker who may look to obtaining a summary of the latest papers on any particular science The sub-title of the periodical is, however, more illuminating, for it reads, "A quarterly summary of articles of interest to Librarians and students of librarianship in the current periodical literature of the United Kingdom, the U S A , etc " These abstracts will indeed be of service to professional librarians, and the need for such a publication is long overdue Such periodicals as *Adult Education, Library World* and *Unesco Bulletin for Libraries* are covered by these abstracts, and subjects dealt with include public, hospital and special libraries, the art of the book, bibliography and bibliographies, and work with children

## Bibliography of Science in Latin America

CONTINUING the sequence in the bibliography of Latin-American scientific activities (see *Nature,* April 15, p 589), the Field Science Co-operation Office for Latin America, in collaboration with various Ibero-American organizations, has issued three lists scientific institutions in Brazil , scientific workers in Brazil , and scientific institutions of the Argentine ("Scientific Institutions and Scientists in Latin-America." Brazil Vol 1, pp 139 , Vol 2, pp 305 Argentina , Vol 2, pp 103 Montevideo Unesco Centro de Cooperación Cientifica para América Latina, 1950) These volumes are more than directories The two lists on institutions give the date of foundation of each institution, indicate its functions and field of work, and contain information concerning staff and publications, a full list of the latter being supplied for some of the entries The other volume on Brazil also supplies much fuller information than would be given in, say, "American Men of Science", a list of publications being included besides particulars of occupation, career and experience, special field of work and details of membership of scientific societies

## Coryndon Memorial Museum, Nairobi

THE annual report for 1949 of the Coryndon Memorial Museum, Nairobi (pp 21 Nairobi Coryndon Memorial Museum, 1950. 1*s* ), records a notable year because at long last an appeal for funds to extend the Museum was launched officially This is for £60,000, £50,000 of which will be used for buildings and £10,000 for equipment and furnishings The Government of Kenya has generously agreed to give £5,000 towards the appeal and, in addition, to grant a further £1,000 for every £3,000 subscribed by the public It is hoped that the full amount will be raised by 1952 , but meanwhile the Trustees have decided that the first part of the building programme was to commence in 1950 This part of the extensions will include halls for entomology, botany, fish and reptiles, while the later part envisages halls for prehistoric and modern man and for geology and palæontology. It is pleasing to note that additional research rooms and storage space are included in the plans.

## Announcements

PROF W T ASTBURY, professor of biomolecular structure in the University of Leeds, Prof Harold Jeffreys, Plumian professor of astronomy in the University of Cambridge, and Prof N V Sidgwick, formerly professor of chemistry in the University of Oxford, have been elected honorary life members of the New York Academy of Sciences

LIEUT-COLONEL FRANCIS J GRIFFIN, general secretary and editor-in-chief of the Society of Chemical Industry, has been invested with the Ordre de la Couronne de Chêne (Order of the Oaken Crown) of Luxembourg for his services to that country during and since the War Col Griffin was for many years registrar of the Royal Entomological Society of London, and was intimately concerned with the formation of the Society for the Bibliography of Natural History in 1936, acting for ten years as its honorary secretary and editor He has been organizer of three recent international scientific conferences

THE National Research Council of Canada has announced the following new appointments in chemistry Dr. Adrien Cambron, to be co-director, with Dr. E W. R Steacie, of the Division of Chemistry and director of the Applied Chemistry Branch, at the National Research Laboratories , Dr Leo Marion to be assistant director of the Division of Chemistry and responsible, under Dr Steacie, for the operation of the Pure Chemistry Branch

DR M C CHANG, of the Worcester Foundation for Experimental Biology, Shrewsbury, Massachusetts, has been appointed supervisor of the cattle ova transplantation programme of the Foundation of Applied Research, San Antonio, Texas For more than eight years this Foundation, which is affiliated with the Southwest Research Institute at Essar Ranch, has been conducting research to enable low-grade cows to produce good-quality calves by acting as 'host mothers' to fertilized eggs transplanted from high-grade animals , so far pregnancies, but no births, have been obtained Dr Chang is a graduate of Tsing Hua University, Peking, and of the Universities of Edinburgh and Cambridge

THE Institution of Naval Architects is offering during 1951 the following scholarships for naval architecture to British subjects (age limit shown in brackets), which, except where otherwise stated, are worth £175 a year and must be applied for before May 31, 1951 *Elgar* (23), for apprentices or pupils in the Royal dockyards or private shipyards (entries before January 15); *Trewent* (19), for apprentices or pupils in private shipyards, *Vickers-Armstrongs* (23), for apprentices or pupils in private shipyards (£220 a year) , *Denny* (19), tenable for four years at the University of Glasgow, with apprenticeship of five years There is a similar Denny scholarship in marine engineering Further particulars can be obtained from the secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S W.1

THE suggestion has been put forward that there is a need for a journal dealing entirely with the use and analysis of words and terminology in science and also in popular and even literary fields It may be possible to start issuing a small mimeographed monthly or quarterly bulletin on this topic at the price of a shilling or two per copy to cover expenses , any suggestions or comments should be addressed to W R Dunlop, 57 Gordon Square, London, W.C 1.

# TELECOMMUNICATIONS IN GREAT BRITAIN

IT has become almost traditional that, when an engineer-in-chief of the Post Office assumes office as president of the Institution of Electrical Engineers, he should give in his inaugural address a broad general review of the state of the telecommunications art in Great Britain

The address of Sir Archibald Gill, delivered on October 5, dealt in the main with the telephone service In his opening remarks Sir Archibald paid tribute to the work of Sir Thomas Purves in the development of the telephone service, and he referred at several stages in his address to the far-reaching decisions made by Sir Thomas in the early 1920's in regard to the form of automatic switching to be adopted by the Post Office and to the appraisal of these decisions in the light of the developments in the twenty-five years since they were taken "Some of the newer systems," said Sir Archibald, "have particular advantages such as greater availability on their switches or speedier operation None, however, has the simplicity and the universality of the step-by-step system, which allows the same components and the same circuits to be used in the smallest and the largest exchanges Thus it is probable that if a similar decision had to be made to-day, the choice would be the same as it was twenty-five years ago

Since 1945 teams of experts from this country have visited all the countries of the world where telephone development has been taking place Much useful information has been acquired as a result of these visits, but nothing we have seen has suggested that the step-by-step system is obsolete or even obsolescent . In fact, it is becoming obvious that there would be no gain now, and it is extremely doubtful whether there would be any gain in the future, in changing the present basic system for any other electro-mechanical system, and that the present system will meet all our needs satisfactorily until such time as something entirely novel appears, as, for example, an electronic system "

The possibility of developing an electronic switching system is, said Sir Archibald, "the subject of much interesting speculation by telephone engineers" A first step was taken towards the introduction of electronic switching equipment by the development of an electronic director which would perform the functions of the electro-mechanical director at present carrying out the routing of calls in large telephone-exchange areas A two-digit electronic director has already been designed and tested, and field trials will be carried out under service conditions so that a direct comparison can be made of the performance of the electronic director with that of its electro-mechanical counterpart

Referring to the progress of the change-over from manual to automatic switching, Sir Archibald stated that to-day 3 6 million stations are served by automatic exchanges, while about one and a half million are still served by manual exchanges

The capital which has been invested in the local-distribution cables and lines connecting telephone subscribers to the central offices in Great Britain represents some forty per cent of the total capital value of the telephone system, and there is in consequence a strong incentive to effect economies in this item of telephone plant One method of reducing the cost of local-distribution cable which has been practised extensively in other countries, particularly the United States, is that of connecting more than one subscriber to one pair of conductors. During recent years when it became necessary to give the utmost service with limited plant, the practice of shared service or party-line working was instituted in Great Britain, and some two hundred and thirty thousand subscribers are at present utilizing this service

The lead-covered, paper-insulated cables at present used for local distribution are not free from disadvantageous features, among which is their vulnerability to mechanical damage and to chemical and electrolytic corrosion Experiments are in progress on the use of the plastic polythene as an alternative insulant and sheath material for distribution cables

In the matter of signalling by dial impulses in the telephone network, the development was initiated during the Second World War of dialling over the trunk network connecting the main centres of population In the system now being used, signals are sent by currents of two frequencies, 600 and 750 c /s , transmitted over the speech circuit. "The present objective in the mechanisation of the inland trunk network is that a controlling operator situated at any trunk centre shall be able to complete a call to any subscriber connected to an automatic exchange anywhere in the country without the assistance of another operator This will result in a considerable increase of tandem dialling over the trunk network, involving in some cases up to six links (four trunks and two local junctions) in tandem connected via the banks of switches "

A study group of the International Telephone Advisory Committee is engaged in examining the more complex problem of long-distance dialling over international circuits It has been agreed among the administrations concerned to subject two schemes to practical trial on circuits inter-connecting London, Amsterdam, Brussels, Paris and Zurich With the mechanization, not only of local-line switching but also of the trunk network, the familiar multiple switchboard with its rows of answering and calling jacks is now disappearing from trunk exchanges and is being replaced by a cordless type of switchboard in which cord circuits are replaced by key-controlled connecting circuits

It is probably in the sphere of long-distance transmission that the most rapid advances have been made in recent years, the two notable developments mainly responsible being the negative-feedback amplifier and the co-axial cable The reduction of intermodulation obtained by the application of negative feedback has rendered it "possible to contemplate putting large numbers of such amplifiers in tandem over long routes and to use them to amplify simultaneously a large number of telephone conversations spread over a wide frequency band extending upwards to a million or more cycles per second"

"The use of co-axial cable solved the problem of cross-talk, or transfer of energy by the coupling between different pairs of conductors, at these high frequencies , for, while it is practicable to produce cables containing twisted pairs in which the cross-talk is not excessive at frequencies up to 100 kc /s , it becomes increasingly difficult to do so at higher frequencies On the other hand, the co-axial cable behaves conversely , it has excessive cross-talk below about 50 kc /s but improves rapidly at higher frequencies " The co-axial cable is essential for the transmission of television signals For purposes of multi-channel telephony on co-axial cable systems, "the agreed international standard system is now 960 channels per pair in the frequency range 60–4,028 kc /s , using ⅜-in co-axial cable with amplifiers at 10-kilometre intervals . For television transmission over these ⅜-in co-axial cables the Post Office is planning to use a vestigial-sideband system in which the video signal modulates a carrier of 1 Mc /s. the upper sideband extending to 4 Mc /s and a vestigial lower sideband extending down to 0 5 Mc /s will be transmitted. This frequency transposition is necessary because the television signals extend to well below 50 c /s and it is impracticable to send such frequencies over the co-axial cable because of cross-talk "

A four-tube co-axial cable was laid between London and Birmingham in 1936, and it was intended to use one pair of tubes for telephony and the other pair for television The growth of traffic, however, brought both pairs into use for telephony and it became necessary after the War to plan an additional cable "At the time when the design of the cable was being considered the Television Advisory Committee under the chairmanship of Lord Hankey had recommended in its report published in 1945 that the television service should be resumed using the pre-war 405-line system and that it should be extended to Birmingham and to other provincial centres, but that development of a higher definition system should be actively pursued The report also visualized that the two systems would have to exist side by side for some time The Post Office was thus faced with the possibility of having to provide, in the near future, transmission facilities for a system requiring a band-width of 10–20 Mc /s As the new cable would occupy the sole remaining duct in the route, it was decided that at least one pair of conductors should be capable of carrying the highest definition television likely to be developed either in black-and-white or in colour " The new cable was therefore designed with two tubes of special construction having outer and inner conductors of 0 975 in and 0 250 in effective diameters This cable has been manufactured and installed, and has been found to come well within the specification limits for impedance, uniformity and attenuation throughout the frequency range of 30 Mc /s At 30 Mc /s the attenuation of the special tubes is less than 9 db per mile The design of amplifiers and compensating networks for television links calls for work of the highest precision, "as the object is to attain a transmission standard which will ensure that the picture is not noticeably degraded after transmission over a distance, ultimately, of at least 500 miles" For the cable television link between Birmingham and Manchester "the gain of each amplifier at the maximum frequency (now 4 34 Mc /s ) is 52 db and the system must be accurately compensated for phase-shift as well as gain/frequency response"

Sir Archibald prefaced his remarks on submarine cables with a reminder that this year marks the centenary of the laying of the first submarine cable across the Straits of Dover The most important advance in recent years in relation to submarine cables has been the introduction of carrier working, as on land cables "This has meant the development of improved dielectrics having lower losses at higher frequencies, and the adoption of the co-axial or concentric type of cable instead of the multi-core type , the most important step in this direction has been the substitution of polythene for natural insulants " The other important advance has been the development of submerged repeaters to permit the use of higher frequencies The first submerged amplifier in a Post Office submarine cable was laid in a co-axial cable between Anglesey and the Isle of Man In 1946 a single amplifier was connected into the cable, 197 nautical miles long, from Lowestoft to Borkum, which had been laid to give direct telephone communication with Western Germany The traffic-carrying capacity of this cable was thereby increased from one telephone and six telegraph circuits to five telephone circuits any one of which may be used to provide eighteen telegraph channels

Further development has been directed towards designing a standard system for co-axial submarine cables of the lengths used on the Continental routes This system, which provides sixty circuits per cable, was first used on the Aldeburgh–Domburg cables, the traffic capacity of which has been increased by a factor of five by the insertion, in each, of four submerged repeaters The operational success of the submerged repeater is naturally dependent on the consistent longevity of its component parts, notably its thermionic valves Considerable progress has been made in the production of small batches of valves with a predicted life in excess of five years

In regard to the overseas radio-telephone services, difficulties are imposed by the limitation of the frequency spectrum available for these services The most effective way of making the best use of this limited spectrum is by developing single-sideband multi-channel working, and considerable progress has been made with the conversion of circuits from double-sideband to single-sideband operation "At the present time 38 circuits are being operated, of which 28 (including one of the two ship services) are obtained by single- or multi-channel operation on 12 single sideband senders . The growth of traffic has been steady On the eight London–New York circuits, the number of calls per week averages about 1,600 and is increasing at the rate of about 200 calls per week per annum "

Television programmes are transmitted, on carrier frequencies of the order of 900 Mc /s , from Alexandra Palace in London to the new television broadcasting station at Sutton Coldfield, Birmingham, by means of a chain of radio links which was brought into use in 1949 The extension of this service will be by co-axial cable to Manchester From Manchester to Kirk o' Shotts near Edinburgh another chain of radio links will be employed Two carrier frequencies in the region of 4,000 Mc /s (7 5 cm ) will be used, and the transmission will be by frequency modulation with a deviation of about 7 Mc /s

Two experimental demonstrations were given during the address The first was of an equipment developed for the amplitude- and phase equalization of the short cable links often used between the pick-up point and the control centre in television outside broadcasts Equalization is effected by trial-and-error adjustment of the equalizer to restore the 'rectangular' form of 20-μ sec pulses, of 0 1 μ sec build-up time, transmitted over the line The second demonstration was the transmission of a television test pattern from the Alexandra Palace studio over the double length of the new London–Birmingham co-axial cable to the lecture theatre of the Institution of Electrical Engineers

JAMES GREIG

# ELECTRONICS SYMPOSIUM AND EXHIBITION

THE third electronics symposium organized by the Scientific Instrument Manufacturers Association was held in London during September 5–8 It followed the practice established last year in being accompanied by a compact, specialized exhibition of electronic instruments for use in research and industry

The proceedings were officially opened by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, and the first address of the symposium was given by Prof G I Finch, professor of applied physical chemistry, Imperial College of Science and Technology, London, who dealt with some industrial applications of electron optics Prof Finch pointed out that electron-optical methods have opened up wide new fields of experimental work for the study of surfaces and their properties For the first time it has become possible to ascertain directly the nature of the atoms and their arrangement in surfaces, and also to map out surface texture to a detail approaching atomic dimensions. It would be difficult to exaggerate the importance to industrial problems of such a searching probe. Absorption, catalysis, crystal growth, adhesion, photo-electric and thermionic emission, mechanical wear and lubrication, corrosion and surface chemistry in general—all find their ultimate explanation in the atomic structure and texture of surfaces

The succeeding sessions on September 6 were devoted to three papers on direct-current measuring and recording instruments In the first, entitled "Recent Improvements in Direct Recording", W Bamford (Everett, Edgcumbe and Co, Ltd) described improvements in the driving movements of recorders in the directions of higher speeds of moving-coil elements, with better control of damping characteristics and the increase of facilities of the servo-operated types with their wide charts and multiple records The limits of frequency response of direct recorders were discussed, and reference was made to a multi-pen pattern operated from a supersonic switching mechanism Among marking devices, the improved ink-on-paper recorders and the latest details of electrical-discharge papers and their applications were described The second paper was presented by R Y Parry and H W Finch (E K Cole, Ltd) on the subject of the "Vibrating Reed Electrometer and its Application to the Measurement of Small Ionization Currents". This comprised a description of a simple vibrating condenser electrometer for measuring small direct currents and voltages under conditions of high impedance The full-scale sensitivity of the instrument is $3 \times 10^{-14}$ amp or 30 mV, and fluctuations of the zero correspond to about $10^{-15}$ amp or 1 mV from day to day under normal laboratory conditions This paper was followed by one entitled "A Review of Trends in *p*H Meter Design", read by G I Hitchcox (Electronic Instruments, Ltd), in which it was pointed out that the essential characteristics of any *p*H-meter are very high input resistance, stability and reliability under unusually severe industrial conditions Further, it must be borne in mind that these instruments are usually operated by engineers from other fields, who may be unacquainted with electronics and often sceptical of the reliability of such apparatus The paper concluded with a description of the practical difficulties which follow the use, for reasons of economy, of ordinary commercial components, and some means were suggested for overcoming or minimizing these difficulties

The morning session of September 7 opened with a paper on "Some Aspects of Electronic Counting", by J McG Sowerby (Cinema-Television, Ltd), in which a variety of electronic counter circuits was described beginning with a scale of two It was shown how ring counters can be derived from the scale of two, and how counters of any scaling factor—including large prime numbers—may be constructed from more elementary circuits Applications of these circuits to frequency division, the measurement of short time intervals, and the measurement of frequency were also described. This was followed by an interesting paper entitled "The Beta-Ray Thickness Gauge and its Industrial Applications" by G Syke (Baldwin Instrument Co, Ltd). The author referred to the fact that, in numerous industrial processes, it is essential to gauge the thickness or weight per unit area of sheets, strips and films, which may be moving at high speed Radioactive isotopes from the atomic pile at Harwell emit ionizing radiations which are progressively absorbed, or attenuated, in passing through matter The ratio of transmitted to incident radiation is a function of the quantity of matter traversed This ratio can be accurately measured by simple electronic instruments, which are calibrated in terms of weight per unit area (gm /m $^2$, mgm /cm $^2$ or lb /sq yd) or directly in terms of thickness for any material of a given density In addition, a balance indicator shows the deviation from a preset weight or thickness The electrical output of the instrument is sufficient to drive recorders or servo-mechanisms for automatic process control Applications to textile, paper, rubber, plastic, metal and other industries were described and illustrated Trends of development, for example, gamma-rays for gauging heavy metals of considerable thickness, were indicated.

It was appropriate that the final paper of the symposium, given by J K Brimley (Nobel Division, Imperial Chemical Industries, Ltd), should deal with the subject from the point of view of the user of instruments, and particularly in relation to the application of such instruments to industrial conditions. Mr Brimley emphasized the fact that electronic instruments intended for use in industry must be designed for factory, and not laboratory, conditions, and it is important to bear in mind the actual physical conditions under which it will be necessary to use the instruments There are also some considerable maintenance problems experienced by industrial users, for in many cases such maintenance has to be carried out by staff not possessing high technical qualifications It is therefore essential that the greatest possible simplicity in design should be achieved, both from the electrical and the mechanical points of view More rapid progress in the production of an instrument for some new application would, in general, be made if the designer and the user collaborated closely during the whole of the design stage

In the exhibition some twenty member firms of the Scientific Instrument Manufacturers Association Electronics Group showed a variety of instruments and associated items; and it was evident from the display that scientific instrument manufacturers are continually extending and improving the applications of electronic techniques in instrumentation A considerable field of application of electronic devices has been opened up in connexion with methods of counting the fundamental particles of Nature, and in problems relating to radioactivity in general, several instruments for such purposes were exhibited. The widening needs of the radio engineer were also catered for in such items as standard-signal generators, field-intensity meters, valve voltmeters and oscillators of various types. The influence of television and frequency-modulation broadcasting has resulted in the production of a television sweep generator covering the frequency-range 40–190 Mc./s., a frequency-modulation receiver tester for the range 21–168 Mc./s., and also a carrier-deviation meter having a signal carrier range of 4–250 Mc./s., with deviation ranges of 0–5, 0–25 and 0–75 kc./s. The continued success and popularity of this symposium and exhibition should do much to assist the development and application of electronic techniques of all types.

# THE BRITISH HAT AND ALLIED FELTMAKERS RESEARCH ASSOCIATION

By Dr. T. BARR

Director of Research

FELTMAKING as a textile industry preceded the manufacture of woven fabrics. In England, it has been an established craft for some centuries, with the Worshipful Company of the Art or Mistery of Feltmakers, a Livery Company of the City of London, controlling its destiny. This Company was granted its first Royal Charter in 1604, but records show that the industry was in existence for at least a hundred and fifty years prior to that date. With such a traditional background, there has been a natural reluctance to change. In addition to this aversion to change, the feltmaker, until recently, has closely guarded his secrets and processes from his neighbour, who was virtually his only competitor.

The pressure of outside events, however, has resulted in a revolution of ideas within the industry, culminating in the formation of the British Hat and Allied Feltmakers Research Association, the laboratories and headquarters of which at Stanley House, Fairfield, Manchester, were formally opened on September 19 by the Earl of Derby.

The change in the attitude of the industry which led to co-operation in the solving of its common problems was clearly expressed by Col. J. A. Christie-Miller (president of the British Felt Hat Manufacturers' Federation), who said: "As a result of two world wars, the opening of new factories in many countries, the installation of new machinery which is largely automatic and does not require skilled men to work it, and because of trade barriers and import restrictions, our competitors to-day are largely overseas." He pointed out that the industry's rough-and-ready methods are no longer adequate if it is to compete in world markets. It must make the fullest use of the scientific knowledge available and apply it to meet the specialized needs of the industry.

Attempts to form a research association for the hat and felt industry date back some thirty years, but it was not until 1943 that any real interest was displayed. Then the efforts made by a small research committee of the Worshipful Company of Feltmakers resulted in laying the foundations for the present organization. The response by firms engaged in the industry surprised even the sponsors of the scheme, whose hopes at the most were centred on securing enough funds to promote one or two research projects in existing laboratories. Once the benefits to be derived from the application of scientific methods in solving the long-standing technical problems of hat and felt manufacture had been appreciated, sufficient support was received from various branches of the industry and associated trades, and it was found possible to make immediate plans for establishing a felt research centre.

The Research Association was incorporated in February 1947, and recognized by the Department of Scientific and Industrial Research shortly after being given the same status as other similar organizations with a substantial grant from Government funds, based on the income derived from the industry. In the same year, the first technical appointment was made, and the work of equipping laboratories and initiating a research programme was begun. Experimental work was started in 1948 in temporary quarters in the University of Leeds, where a laboratory was rented from the Department of Textile Industries. Although space was limited, the freedom to use the equipment and library facilities available at the University was of inestimable value in the early days of the Association while a permanent home was being found and equipped.

The research programme of the Association is decided and controlled by three research committees, representing the three main sections of the industry, producing wool felt, fur felt and hatters' fur respectively.

The initial programme took full cognizance of the fact that the industry, having developed by empiricism and reliance on rule-of-thumb methods, was lacking in quantitative methods of assessing progress. Therefore, the physical properties of felt are being studied in the hope that tests will be evolved as yardsticks for the trade. Arising from this study, a scheme for the quality control of felt has already been worked out which separates 'bulk' properties from 'fibre' properties. This scheme has found many applications and has provided members of the Association with the means of measuring changes in the quality of felt resulting from the modification of manufacturing procedure; and at the same time it has made it possible to determine whether or not the fibres from which the felt is manufactured have undergone any degradation during processing. In measuring the tensile properties of the felt, which forms an essential part of the scheme, it was discovered that the shape of the load-extension curves of the test samples is related to the previous history of the felt. The full significance of this discovery is demonstrated by the fact that it has repeatedly been used for solving 'blocking' problems of hat manufacturers.

The research projects also include studies such as that of the 'carrotting' process—the preparatory chemical treatment for rabbit and other furs, without which they lack the requisite properties for felt manufacture. A fundamental study of carrotting was begun in order to elucidate the chemistry of the reactions and the mechanism of the changed felting properties arising from the treatment. Considerable advances have already been made in this line of research, and a better understanding has been reached of the chemical groups of the fur molecule which take part in the reaction. As a result, there is a prospect of the early development of a reliable test for the degree of carrotting of fur.

In the field of technological research, the staff of the Association is engaged in studying the different processes in the manufacture of felt from both wool and fur. Felting of these animal fibres is carried out in an acid medium, sulphuric and phosphoric acids being normally used for the purpose. Arising from work carried out by the Association in the industry, recommendations for the control of acid additions have been made and have been adopted with advantage by a number of member firms.

Further research projects of immediate benefit to the industry cover other processes such as dyeing and proofing. With the occupation of the new laboratories and the increase in staff thus made possible, widening of the scope of the programme is envisaged.

The building houses a chemistry laboratory; physics laboratory; dark room for optical and photographic work; and a testing laboratory for operations at controlled temperature and humidity. The addition of a technological block for carrying out small scale industrial operations has been planned, and an early start on this project is expected.

Although the industry is not a large one and most of the firms are of the small 'family' type, it makes a useful contribution to the national economy. It is gratifying to note that the hatters' fur manufacturers, who supply the raw material for the fur felt section, are solidly in support of the research association, and that the majority of hat felt manufacturers in Great Britain are members, while manufacturers of machinery and dyestuffs and ancillary trades are strongly represented.

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# BATTERSEA LABORATORIES OF THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION

THE British Iron and Steel Research Association celebrated the third anniversary of the official opening of its Physics Laboratories at 140 Battersea Park Road, London, S.W.11, by holding 'open days' on November 9 and 10. The laboratories were originally opened by Lord Rayleigh on October 22, 1947 (see *Nature*, **160**, 684; 1947). The 'open days' were planned to indicate that during these three years a number of researches have led to results either having direct practical application in the steel industry or throwing light on the fundamental problems connected with iron- and steel-making and therefore of indirect value. The general plan of the Research Association under its director, Sir Charles Goodeve, is to have six Divisions (Iron Making, Steel Making, Steel Castings, Mechanical Working, Plant Engineering and Metallurgy) directly concerned with the six main groups of processes in the industry, and two Departments, Physics and Chemistry, which serve the requirements of all the six divisions. The laboratories at Battersea house the whole of the Physics Department (under M. W. Thring), a part of the Chemistry Department (under Dr. J. Pearson) and the Electrical Engineering Section of the Plant Engineering Division (under H. H. Mardon).

## Physics Department

A booklet entitled "Physics in the Iron and Steel Industry" describes the work of the Battersea laboratories of the Research Association and also contains short accounts from seven big steel companies of the use of physics in their laboratories. These accounts show how the increase of efficiency and reduction of wastage in an industry causes a steady growth in the reliance upon accurate instruments for measurement, control and investigation of untoward occurrences. For this reason also, one of the five sections of the Physics Department is entirely devoted to the development of new instruments for the industry.

The physics of the various phenomena occurring in the manufacture and use of iron and steel provides the field for the work of the remaining four sections. It is clear that the present tendency among many physicists to regard the atomic nucleus as the only region of the universe which contains new and unrevealed general laws is far from justified, and much fundamental work of the greatest interest is being done already on the physics of the strength and plastic deformation of metals. Other phenomena of equal interest to the physicist are freezing and crystal growth under various types of cooling and with various impurities in the main element, the way in which atoms find their new positions in a transformation, the mixing of two fluids, heat transfer by convection from a gas jet, luminous radiation, the production of fine droplets by fluid impingement, the movement of a liquid under the impact of a gas jet, and splashing.

The following general ideas run through much of the work described: (1) the attempt to develop equipment for observing phenomena while they are occurring rather than relying on freezing them for subsequent study, and for probing inside complex systems to measure the physical conditions; (2) the application of methods of planning experiments which have been largely developed by the agriculturists to steel-industry investigations both in the laboratory and in the works; (3) the linking together of experiment and theory based on suitable simplifying assumptions; (4) the use of model techniques for studying systems of too great geometrical complexity for a fully mathematical treatment; (5) the application of physical techniques developed for quite other purposes to solve problems of the steel industry.

In the General Physics Section (J. Savage) the physics of the freezing of steel moving relative to a water-cooled mould surface has been intensively studied with the view of providing the fundamental background to the continuous casting of steel, a process which is just coming within the range of practical industrial operation. Measurements have been made of the friction between a 2½-in. diameter mould and the freezing metal, the heat transfer through the mould and the variations in surface quality at different rates of casting and different steel superheat temperatures. In this connexion, also, a vacuum apparatus incorporating an Andrade balance has been built to study the plastic flow of steel at temperatures between the $A_3$ point and the melting point. The flow-rate has so far been evaluated for one steel from 950° to 1,400° C. over a range of stress of 80–280 kgm./cm.$^2$. This Section has also applied the Geiger counter to the X-ray diffraction observation of transformations in steel while they occur, and to fluorescence analysis, and has developed a high-magnification, high-temperature microscope.

The Instrument Section (S S. Carlisle) has developed two instruments which are already in use in the industry, a sensitive differential pressure meter giving an electrical signal suitable for remote indication and automatic control of furnace pressures, and a wire-drawing die profilometer which enables the wear on a die to be observed to very fine limits A fully automatic instrument is now in the laboratory Two other interesting applications of physical principles are the meters which measure the width of a 16-in strip with an accuracy of 0 01 in although the strip moves laterally by 0 125 in , and the thickness of steel plates from one side by measuring the magnetic saturation flux density

The Heat and Thermodynamics Section (R Mayorcas) has worked on the measurement of temperature and radiation from liquid and solid steel, the inside surface of furnace walls and gases Methods of measuring surface temperatures have been developed which avoid errors due to variations in surface emissivity by the use of reflecting caps, while a neat and compact furnace gives a source of radiation, 3 in diameter and up to 1,750° C , which is very nearly a full radiator A calorimeter instrument measures the sensible heat content of flame gases for the construction of partial heat balances The Section has also taken a considerable part in the flame radiation trials carried out in Holland jointly with Dutch and French scientific workers (see *Nature,* August 12, p 255)

Rather more than half the work of the Aerodynamics Section (M P Newby) has been devoted to problems of gas and air flow, mixing and impingement on refractories in the open-hearth furnace The flow resistances and flow patterns have been studied with cold-air models and on a full-scale furnace operated with cold air, and a special technique has been developed for measuring mixing patterns by the use of carbon dioxide and methane as tracers the presence of which is detected by the infra-red gas analyser A new type of Pitot tube giving a relatively high Reynolds number for a low velocity has been developed for use in furnaces, the shape of orifices to give a constant coefficient at low Reynolds numbers and the flow of gas and steel in the sideblown converter have been studied.

The Mathematics Section (H Herne) devotes about equal fractions of its energies to the attempt to provide a theoretical background to experimental work in the British Iron and Steel Research Association and to statistical design of experiments and evaluation of results The blast furnace and the open-hearth furnace have been studied in both ways , in the former case the theory relates to the heat balance in stages, and in the open-hearth furnace to the details of heat transfer A six-variable two-level factorial trial has been planned for an open-hearth furnace and executed by a steelworks, giving significant results for five of the variables The solidification and stresses in castings have been calculated by numerical means Another interesting theoretical study relates to traffic analysis in steelworks and ore-handling ports

## Chemistry Department

The work carried out in the laboratories (under J H. E Jeffes) at Battersea which form part of the Chemistry Department is mainly fundamental research work on the physical chemistry of the processes which are used in the iron- and steel-making industry At the present moment researches are in progress on the following topics (1) the rate and mechanism of the reduction by hydrogen of thin films of iron oxides on pure iron ; (2) the equilibrium conditions of phosphorus in solution in liquid iron in contact with a solid lime and tetracalcium-phosphate pair at various oxygen potentials , (3) the partition of sulphur between gas and slags under various conditions of slag composition and oxygen potential , (4) the stabilities of various sulphides at high temperatures using radioactive sulphur ; (5) the heats of formation and high-temperature heat contents of slag components , (6) the construction of a vacuum fusion apparatus for the determination of gaseous substances dissolved in steel samples, etc

## Plant Engineering Division

A control device has been developed for application to a hot-strip mill in order to compensate for the increase in finished thickness which occurs from front to back of a long strip of steel The screwdown motors in a tandem mill are operated intermittently according to a preset programme based on previous strip measurements All presetting and control is effected at a power-level consistent with the use of standard post-office equipment, resulting in compactness, cheapness and reliability.

Another strip gauge control, originating with the Mechanical Working Division, uses the mill itself to measure the strip thickness and modulates reel tension as the output signal The Plant Engineering Division has devised the closed loop, and it is shown that the output is expressible as a sixth-order differential equation

A novel method for cleaning industrial gases, such as blast furnace gas or flue gas, uses water sprays of a controlled size thrown from the periphery of a series of rapidly rotating disks arranged in the centre of the pipe along which the dirty gas is passed This gives a high degree of dust removal with the minimum expenditure of energy and water

A small-scale cleaner having a capacity of 6,000 cu ft /hr mounted in a mobile laboratory truck for convenience in doing trials at steelworks, and a larger unit to treat 100,000 cu ft /hr , were on view In the latter machine the five disks of 16 in diameter are rotated at 5,000 r p m by a 2-h p steam turbine The water drops have an initial speed of 300 ft /sec and a size of 100 microns This dense mist of drops is thrown across the dirty gas stream as it passes through an annular space surrounding the disks The machine is about to be installed in a steelworks for trial under production conditions

Dynamic stresses in gantry girders such as occur when a crane picks up a heavy load are being studied with strain gauges. Steelworks crane cabs are being improved in several ways , for example, master controllers have been completely redesigned to give near spacing These now have vertical handles moved radially instead of the 'tramway' controller motion usually adopted, and maintenance inspection and replacement of contact assemblies can be made without detaching any wiring from the controllers The driver will be seated in a special seat based on one designed for the Admiralty to ergonomic principles by the Department of Human Anatomy, Oxford, and Messrs Fairey Marine, Ltd , and the controllers will be grouped around the driver for optimum ease and accuracy of working The new controllers and cab lay-outs will be in line with the new specification of the British Iron and Steel Research Association for heavy-duty electric overhead cranes

A rotary chart translator enables a large number of circular charts to be re-recorded on a single strip chart with a reduced time base to facilitate a detailed study of blast-furnace blowing requirements A 48-way recorder enables temperatures at different points in ingot moulds after teeming to be studied

# TECHNICAL BOOKS AND INFORMATION

THE Scottish Branch of Aslib held a conference in the Mitchell Library, Glasgow, on October 6 The conference was opened by Mr C A Oakley, who spoke on this occasion as the author of several technical books, and not in his official capacity as regional controller for Scotland of the Board of Trade He regretted that Glasgow has a reputation as a 'tough' city, largely due to certain books written about it, and said that he had written "The Second City" in answer. Mr Oakley went on to suggest that this unsavoury reputation is a factor in the problem of bringing new industries to Scotland There is no difficulty in persuading managers to come and live in the Glasgow area, but the charge-hand type of worker has taken his idea of the city from news and books Describing his own experience, Mr Oakley said that too frequently an author of technical books has to meet the cost of publication, and it is rare that this type of book produces substantial royalties It may take ten years to collect the material, and technical books are better if they are written slowly over a period of years rather than tackled and finished in a few months

Mr. James Fergusson, Keeper of the Records of Scotland, outlined the history and care of the records of Scotland and stressed that the live, active interest of the people is necessary to solve the problems facing Register House.

Sir James French, speaking on "Books in Industry", said that books should be available for self-education, and advocated numerous well-distributed collections of technical works He suggested that money for this would be well spent, and could well be saved by reducing the school-leaving age to thirteen His experience over many years has proved that youths at thirteen are ready and willing to leave school, and gain more from an earlier apprenticeship to a trade than from an enforced attendance at school, which bores them and wastes their time. Sir James said that even the most modern books are in some degree historical and that "pioneers of industry spend their lives hunting in unknown forests for which there are no guide books, until they themselves may write them"

The next speaker, Mr W A Beck, superintendent for Scotland of H M Stationery Office, outlined the publications available and described the various classes of papers published The last paper, by Mr S Weinberg, research manager of Messrs G and J Weir, Ltd, was on "The Attitude of the Research Worker to Technical Information" He quoted Sir Alfred Egerton, giving the present rate of publication of scientific papers as approximately one million, ninety per cent of which are only written to publicize their author's existence There is no easy solution, because a publication giving arbitrary results might well have a value in the experimental techniques described Too often the librarian regards the research worker as an individual pursuing a certain line of inquiry for a particular project. Ninety per cent of his reading time must be allocated for routine 'keeping abreast', but reading time for a specialized job cannot be arbitrarily decided. Mr Weinberg said that it is useless for the research worker to attempt to examine more than one-tenth of one per cent of published material, which works out at twenty to twenty-five papers or articles a week Of these, one-tenth may be of immediate interest, and a fraction of wider interest In this connexion, it was stressed that editors cannot pay too much attention to the 'contents' page Selection of material should always be the responsibility of the research worker and should not be left to the librarian, although the latter can usefully do the routine work of abstracting after the initial selection From experience, Mr Weinberg regretted that the emphasis in abstracts is on results, which are often of less use than the operational techniques and the experimental results prior to analysis

Mr. Weinberg put forward a plea for discrimination on the part of editors and secretaries of learned societies, and he hoped that the advantages of personal publicity would be reduced in such a manner as to discourage all but the better papers Repetition should either be avoided or clearly indicated Until it is possible to dial the number of the information required and see it flashed on a screen, the bringing together of the librarian and research worker on a personal basis is most likely at this stage to produce beneficial results

# MILK RECORDING AND BREEDING OF DAIRY CATTLE

SINCE most of the important statutory activities of the Milk Marketing Board were taken over by the Ministry of Food at the beginning of the Second World War, and have not yet been restored to it, a good deal of the energies and the not inconsiderable financial resources of the Board have been of recent years devoted to the milk recording and breeding movement, with the ultimate objective of improving milk yields per cow and also milk quality Dr Joseph Edwards, head of the Production Division of the Milk Marketing Board, in an address to the Farmers' Club at a meeting in London on October 2, gave a valuable account of the extensive progress made in three fields milk recording (National Milk Records) since the Milk Marketing Board took over this scheme from the Ministry of Agriculture in 1943, the development since 1947 of the Milk Marketing Board Bureau of Records, and artificial insemination of dairy cows which, following the pioneer work started in 1942 at the experimental centres at Cambridge and Reading, was taken up on a commercial scale by the Board in 1945

In the first of these fields, the number of recorded herds has gone up from just over 4,000 to more than 24,000, about twenty per cent of the dairy cows in England and Wales are now recorded for yield Some progress has also been made in recording butterfat percentage, about seven per cent of dairy cows are now in the scheme All recorded cows are identified by ear-marking, itself no inconsiderable task As regards development since 1947 of the Bureau of Records, this Bureau publishes annually a report and analysis of the figures obtained from the National Milk Records, a publication of real value to most of the organizations and individuals interested in herd improvement, it also provides statistical and other services for artificial insemination centres and collates much data for the various breed societies and others In the field of artificial insemination the progress has been particularly striking The number of cows artificially inseminated from Milk Marketing Board centres has risen from 6,401 in 1945–46 to no less than 431,402 in 1949–50 In non-Board centres the number inseminated in the latter year was 172,321, so that the total for the country is well over 600,000, that is, some twenty per cent of the dairy cattle in England and Wales are now served artificially by bulls of which the great majority are well above average quality

The records quoted by Dr Edwards show the rapid advance in numbers in recent years of the heavy-yielding Friesian (or Friesian-type) animals, which now form as much as 32 per cent of the total national herd He also gave some interesting figures indicating fluctuations in herd fertility (disclosed by artificial insemination)

From Dr Edwards's figures and conclusions, which are borne out by all recent experience, it is clear that, at present, the main limiting factor in milk production in many herds is not heredity but dairy farming technique, particularly in relation to grassland improvement and pasture management

H D KAY

# FILMS AND FILMSTRIPS IN FUNDAMENTAL EDUCATION

PRODUCED in collaboration with Unesco, four new educational pamphlets of Film Centre, Ltd., discuss the role of films and filmstrips in fundamental education The first, "The Film and Fundamental Education", shows that the full development of the film in fundamental education must depend to a large extent on governments The finance and the resources involved are considerable, particularly for production But whatever the contribution made by governments, a very large measure of initiative still lies with non-official organizations of all kinds, especially in the field of film use

In many areas where the population is scattered, mobile units are likely to remain the most effective means of showing films for some time to come Since the equipment of a mobile unit costs several thousand pounds, the responsibility will continue to lie mainly with governments Ultimately, however, mobile units must make way for static projectors in each community, if films are to gain a regular and accepted place in local life At this point private organizations should be ready to play their part Where an individual organization is unable to afford the cost of a projector, a co-operative film service, uniting a number of bodies or persons prepared to contribute, can provide projection equipment and skilled projectionists The service is also capable of further extension to include training courses for its members, and even a film lending library service

In this context the Film Councils, developed in Canada and the United States, provide a very relevant example These Councils bring together local bodies of all kinds—youth clubs, women's institutes, churches, chambers of commerce, trade unions, industrial firms, farmers' groups and others—for a common purpose, to promote the educational use of the film The Ottawa Film Council, for example, has more than a hundred affiliated organizations The main value of the Council is twofold By the pooling of finances the resources available to the community can be very considerably increased The fullest possible local participation is also ensured

Popular initiative and use of co-operative methods are, in fact, the keys to success In the last analysis, fundamental education can only be a living and creative movement if it is a movement of the people themselves, working together for the advancement of the whole community and with it the whole nation.

The second pamphlet describes the most suitable apparatus for the projection of films and filmstrips in fundamental education, while the third and fourth pamphlets deal with the choice and care of films and filmstrip in fundamental education

# ACCEPTANCE SAMPLING

AT the first post-war meeting of the American Statistical Association, held in Cleveland, Ohio, in January 1946, an all-day session was devoted to statistical methods of acceptance inspection, and the proceedings of this session have recently been published* It is a pity that there has been more than four years delay in publishing this material, as its prompt appearance would have had a stimulating and clarifying effect As it is, considerable further development of the subject has occurred, and the book is somewhat out of date. A good deal of it will make worthwhile reading, nevertheless, to anyone interested in industrial inspection.

The first half of the book is devoted to acceptance sampling by attributes A short history of developments prior to 1941, by Paul Peach, is well written and good, except that no reference is made to British work (one has to admit, however, that not much British work had been published) E G Olds, in a review of war-time developments, gives clear descriptions of the various methods available (though the relations between them are not always shown up well) and has compiled a good bibliography Then follows the most interesting feature of the book, a verbatim report of a long discussion on sampling by attributes The seventeen contributors appear to speak from extensive experience and to have really thought about the subject, and their discussion is remarkably shrewd and to the point

The second half of the book, devoted to acceptance sampling by variables, is less interesting J H Curtiss applies the language of the Neyman–Pearson theory of testing hypotheses to deal with a limited range of problems arising with specifications of population mean. A short summary is given of a paper by W A Wallis on using measured values of a variable to estimate the proportion falling beyond some limit and classed as "defective", instead of merely noting the proportion of defectives directly, a full account has been published in "Selected Techniques of Statistical Analysis" (London McGraw-Hill Publishing Co., Ltd, 1947) The ensuing discussion on sampling by variables, though it brings out some interesting points, rather flags by comparison with the first discussion J W. Tukey, as chairman, gives a good summing-up

F J ANSCOMBE

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* Acceptance Sampling a Series of Papers and Discussion on the subject of Acceptance Sampling delivered at the 105th Annual Meeting of the American Statistical Association at Cleveland, Ohio, on January 27, 1946 Pp iv+155 (Washington, D C American Statistical Association, 1950)

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications*

## Immersion and Survival in Cold Water

A SURVEY of the results of experiments performed in baths[1] suggests that few men would live in water near freezing point for more than 30 min and none for more than 1½ hr Yet some people derive much pleasure and no harm from brief immersions in such water, and shipwrecked people are known to have survived after spending several hours in icy seas Thus, Molnar[1] has quoted a group of twenty-three people who all survived long immersion in the sea although experiments performed in baths suggested that this should have lowered their rectal temperatures to 24° C , and he was surprised to find in another report that three men who had no life-jackets could hold up their heads after 1 hr in water at 4–7° C Critchley[2], moreover, has quoted an example of a man who survived after swimming for more than half a day in water at $-1\ 5°$ C The following observations and calculations may explain this apparent contradiction

All tests were performed on one subject aged thirty-six years, 180 cm high, and weighing 85 kgm , who was a moderate swimmer and unaccustomed to cold water The calculations apply to a man of his size He first swam for about half a minute in an arctic sea inlet at a water temperature of 3° C When he came out of the water his skin temperature was only slightly lower than it had been before, and it returned to near its original level within 10 min. although he was not artificially warmed His rectal temperature rose by 0 4° C immediately after the swim , this was probably caused by a mechanism which has been discussed elsewhere[3]

It can be calculated how fast this subject was losing heat in the cold water if it is assumed that his surface area[4] was 2 05 $m^2$, the average conductivity of his superficial tissues between 9 and 10 Cal /$m^2$/hr /° C [5-7] and the temperature of his deeper tissues near 37° C (though it cannot be said exactly what the latter was[3]) At water temperatures of 0–5° C , this man should have lost some 12 5–10 Cal /min Since his specific heat was probably 0 83 [8], this rate of loss would have lowered his average body temperature by about 0 18–0 14° C /min It is clear, therefore, that immersions of a few minutes in very cold water cannot cool the body to a dangerous extent

Experiments have since been performed to study the heat production during swimming They were done at water temperatures of 20° C and air temperatures of 15–20° C The subject swam with a Douglas bag on his back Samples of expired air were analysed in Haldane's apparatus[9] and the heat production was calculated from the oxygen consumption The results are given in the accompanying table If the subject had been swimming in colder water his heat production would have been at a similar level, because it is evident from Spealman's data[10] that in the absence of shivering the heat production of a subject immersed in water does not depend on the water temperature Even if the actual heat losses were a little higher than those calculated above[11], a man who is swimming hard should produce about as much heat as he loses in water near freezing point, and he should not die of cold as long as he is able to swim Stiffness of the muscles may eventually interfere with efficient swimming , but muscles which are being exercised hard may remain warm enough to prevent them from becoming stiff After rescue, moreover, a man who has been swimming would not require to warm his limbs at the expense of more important regions of his body[3], and he would continue to have a high level of heat production for some time This may be a great help in resuscitation Men in baths may shiver, but only after they have lost much heat, and they cannot produce enough heat by this means alone to balance their losses in very cold water[11]

HEAT PRODUCTION WHILE SWIMMING

| Activity before collection | Activity during collection | Period of collection (min ) | Heat production Cal /min | Heat production Cal /$m^2$/hr |
|---|---|---|---|---|
| Squatting near pool | Slow swimming | 1 | 8 | 234 |
| Squatting near pool | Slow swimming | 2 | 10 5 | 307 |
| Slow swimming | 'Treading water' | 1 | 7 5 | 220 |
| Moderately hard swimming | Moderately hard swimming | 1 | 12 5 | 365 |
| Slow swimming | Squatting near pool | 2 | 4 5 | 134 |
| Lying still | Lying still (basal metabolic rate) | 12 | 1 2 | 34 1 |

Fit men, therefore, who are in danger of immersion in cold water, might be advised to swim or struggle as hard as they can for as long as they can If they try to preserve their strength by clinging to wreckage or floating on their lifebelts, they will die from cold Perhaps more lives would have been saved in the past if this had been understood

My thanks are due to Prof R A McCance for his interest and help, to the captain of H M S *Truelove* (Cdr A S Jackson, R N ) for allowing the arctic experiment to be conducted from his ship, to the Master and Fellows of Emmanuel College, Cambridge, for the use of their swimming pool, and to Surg Lieut G R Hervey, R N V R , for determining the metabolic rates

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## Comparison of Archæological and Radiocarbon Datings

SEEING that the radioactive carbon method for dating the past so lucidly described by Prof F. E. Zeuner in *Nature* of November 4, p 755, was evolved primarily to test certain physical hypotheses, it may be of interest to physicists to see how far the application of the method to materials relatively or absolutely dated by archæological methods yields consistent or confirmatory results  More than five hundred radiocarbon dates have now been published[1]  Attached to each is the standard deviation, "consisting solely of the error of counting random events"  These dates include seven objects from Egypt and five from northern Europe, at least the relative ages of which are well established by archæological methods

EGYPT

| Object No | Archæological period or site | Historical age in years before present | Radio-carbon dates | Average | Average B C dates |
|---|---|---|---|---|---|
| 62 | Ptolemaic (coffin wood) | 2280 | 2190±450 | | 240 |
| 81 | Sesostris III (tomb) | 3750 | 3845±400<br>3407±500<br>3642±310 | 3621 | 1671 |
| 12 | Sneferu (tomb) | 4575±75 | 4721±500<br>4186±500<br>5548±500<br>4817±240 | 4802 | 2852 |
| 1 | Zoser (tomb) | 4650±75 | 3699±770<br>4234±600<br>3991±500 | 3979 | 2029 |
| 267 | Udimu (Hemaka's tomb) | 4900±150 | 4803±260<br>4961±240 | 4883 | 2933 |
| 463 | El Omari (? Neolithic) | | 5256±230 | | 3306 |
| 457 | Fayum *A* (Neolithic) | | 6054±330<br>6136±320 | 6095 | 4145 |

The very wide discrepancies in the estimated age of the same object in the cases of objects 1 and 12 will be at once noticed , but it should be remembered that these are among the earliest experiments  The radiocarbon date for the roof beam of the tomb of Hemaka, vizier of the fifth Pharaoh of the First Dynasty, favours the higher of the historically possible dates for the unification of Egypt under "Menes"  While the settlement at El Omari is still formally neolithic, it was occupied for a considerable time and might well be regarded as later than the Fayum neolithic (Object 457), though surely substantially earlier than the foundation of the First Dynasty

NORTHERN EUROPE

| Object No | Archæological period or site | Radiocarbon dates | Average | Average B C dates |
|---|---|---|---|---|
| | Neolithic | | | |
| 462 | Ehenside Tarn (wood) | 4964±300 | | 3014 |
| | Mesolithic | | | |
| 434 | Boreal, Zone VI* (Aamose, charcoal) | 8631±540 | | 6681 |
| 433 | Boreal, Zone VI (Aamose, hazelnuts) | 9935±440<br>9927±830 | 9929 | 7979 |
| 432 | Boreal, Zone V (Aamose, pine cones) | 7583±380 | | 5633 |
| 353 | Pre-Boreal, Zone IV (Starr Carr, wood) | 10167±560<br>8808±490 | 9488 | 7538 |

* The sequence of zones, defined by pollen analysis, has been established stratigraphically by Prof K Jessen and Prof H Godwin

Britons will be pleasantly surprised to find that a full neolithic settlement in Cumberland, which on archæological grounds should certainly be later than the first neolithic sites of southern England, should be so ancient  The discrepancy between 433 and 434, hazel-nuts and charcoal respectively, from the same temporary camping place on Aamose in Zealand, may disclose a serious methodological defect  The date for 432 is so discordant with 433 and 353 as to suggest that the samples have got mixed up  On archæological and palæobotanical grounds, the wooden platform on the edge of the former Pickering Lake in Yorkshire excavated by Dr Grahame Clark must be substantially older than the foregoing Danish sites (432–34)  The discrepancy between the results obtained from two pieces of wood from this platform is alarming , but the average happens to agree rather well with the estimates of the age of the climatic phase and pollen zone to which, based upon the geochronological method of de Geer, it belongs

In conclusion, it might be noted that if object 75 represents, as appears, the date for the beginning of agriculture in the Chicama valley of Peru, that would have happened 2,300 years later than in Cumberland  But a mere archæologist feels that the method will require considerable checking and refinement before it can provide reliable dates for prehistoric events

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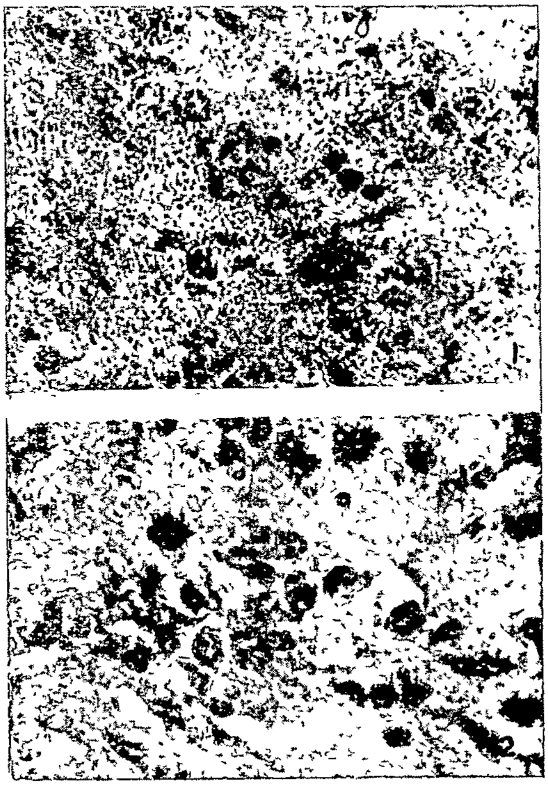
## Autoradiographic Evidence for the Occurrence of Organic Iodine in the Anterior Lobe of the Pituitary Gland

USING sodium iodide labelled with iodine-131 (supplied by the Atomic Energy Research Establishment, Harwell), we have studied by the autoradiographic technique the distribution of iodine tracer doses in the pituitary gland of the guinea pig



Photomicrograph of the pituitary gland of adult guinea pig, with autoradiographs superposed  The reduced silver grains are present only in the anterior lobe (Fig 1), and are completely absent in the posterior lobe (Fig 2)  × 395

Each of a group of adult animals was injected with a single dose of 0·3 γ of iodine (corresponding to the quantity contained in the animal's normal daily food), containing 250 μC of iodine-131 The animals were killed after 24 hr and the pituitary and thyroid glands removed These were embedded in paraffin, and then histological sections of thickness 2–5 μ were prepared, mounted on microscope slides, covered with Kodak stripping emulsion for autoradiography and exposed[1]

The thyroid sections were exposed for 18–24 hr, and in the resulting radiographs the occurrence and distribution of iodine were in complete accord with the findings of other authors[2] These radiographs served as controls on the quality of the emulsion and the method of development, and at the same time acted as checks on the observations on the pituitary

The pituitary sections were found to be only weakly active and in consequence were exposed for the maximum time advisable, that is, about three half-lives (21 days), after this time the plates were developed and then stained with Hæmatoxylin and Eosin Under the microscope, it was possible to see a weak impression in the emulsion corresponding to the anterior lobe of the gland and its pars tuberalis, but there was no evidence for the presence of iodine in the posterior lobe Fig 1 shows a portion of the anterior lobe and Fig 2 a portion of the posterior lobe, on which the corresponding autoradiographs are superposed

Since the iodine fixed selectively in the anterior lobe is in organic form—as is shown by the fact that it is not soluble in the liquids normally used in the preparation of histological sections[3]—we think that our observations confirm the statement of Sturm and Schneeberg, and of Joliot and co-workers[4] on the property of the pituitary gland of fixing thyroxine in a specific manner The present result, however, seems to demonstrate the direct influence of the thyroid on the anterior pituitary

Work on this subject is still in progress and will be reported fully elsewhere

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## Surface Structure of Feathers from the White Domestic Fowl

The cuticle of an animal fibre consists of a thin membrane, the epicuticle[1], covering the surface, and at least two more layers, the exo- and endo-cuticle[2] The epicuticle of wool has been especially studied at this Institute, and work is now being carried out on its fine structure and chemical composition Related subjects such as the feather vane and down from the white domestic fowl have also been examined in the electron microscope in order to see if any corresponding layers could be found

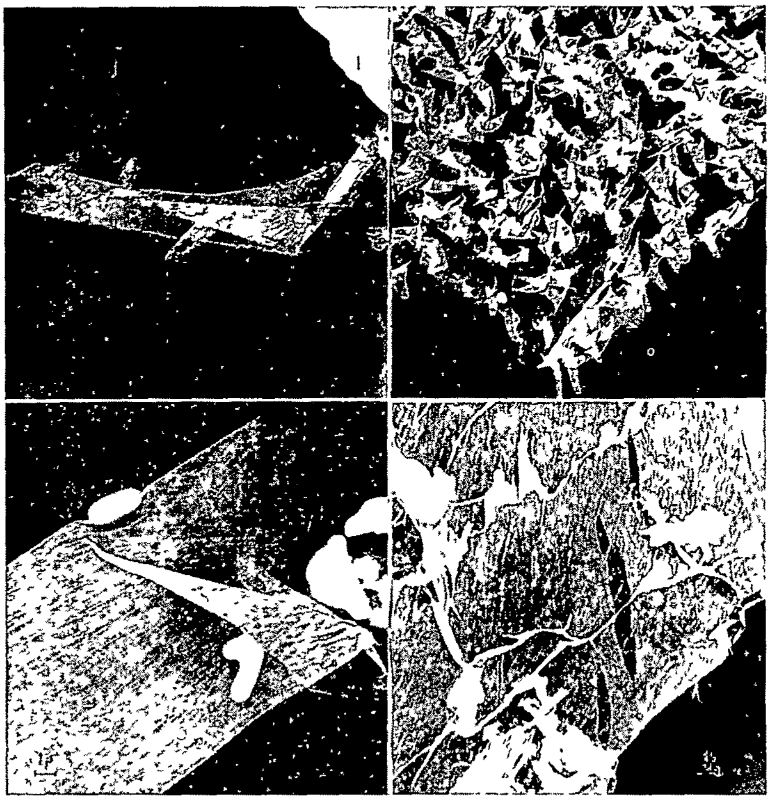

Fig 1 Fragmented membrane obtained by bromination of feather vane followed by shaking with water Palladium shadowing, 4 to 1

Fig 2 Membrane covered with sacs, from tryptic digest of phenol-treated feather vane Palladium shadowing, 4 to 1

Fig 3 Tube-like striated membrane from tryptic digest of phenol-treated feather down Palladium shadowing, 4 to 1

Fig 4 Double striated membrane from alcohol-bisulphite dissolved feather vane Palladium shadowing, 4 to 1

The chemical and enzymatic treatments of the feather specimens were essentially the same as those earlier used for wool[3] After a slight bromination followed by shaking with water, the membranes shown in Fig 1 were found in the suspension They resembled very much the epicuticle isolated from wool in a similar manner However, these membranes seemed to be more brittle and did not occur in such large pieces as in the case of wool The thickness was slightly less than 100 A

Phenolic treatment (50 per cent phenol in water, 2 hr at 100° C) followed by digestion with trypsin[3] produced big pieces of thin membranes, some of them completely covered with small sacs of the cornet-like shape shown in Fig 2 These sacs give a velvet-like appearance to the surface of the barb and might be helpful in increasing the water-repellency properties, and also in reducing the mobility of air within the feathers for heat insulation and during flight In the same specimen were also found sheaths showing striations which gave the impression of a replica of bundles of microfibrils This can be seen in Fig 3, which is from a preparation containing only downy barbules The thickness of the membranes from the phenolic treatment varied between 50 and 200 A Similar results were obtained by dissolving the feather parts in dilute sodium sulphide

Thicker sheaths, up to 0 1 micron in thickness, were obtained when feather barbs were dissolved in 50 per cent alcohol to which had been added some 0 1 per cent sodium bisulphite[4] These membranes were mostly double (originating from both sides of the barbules), and in the optical microscope it could be seen that they still retained the contours of the original feather parts In the electron microscope, marked striations and also compact ridges could be observed These ridges might belong to cell walls (Fig 4)

The treatment with phenol and enzyme or with alcohol and bisulphite leaves only the outer parts of the feather vane and down undissolved From the different action of the reagents it can be concluded that the keratinous body is enveloped by a cuticular sheath approximately 0 1 micron thick, consisting of at least two layers The external of these, practically unattacked by tryptic digestion, is the same as that freed by bromination It is the most resistant one and is analogous to the epicuticle of wool Beneath there is the second layer, which is digestible by trypsin but unattacked by alcohol and bisulphite This layer might correspond to the exocuticle of wool

Further details of this investigation will be published elsewhere These studies of the epicuticle have been aided by a research studentship to one of us (G L ) from the International Wool Secretariat

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## Superconductivity of Tin Isotopes

MEASUREMENTS have been made of the superconducting transition temperatures and critical fields of nearly pure tin isotopes separated by the electromagnetic method, the mean atomic weights provisionally determined by mass spectrograph were 116 2 ± 0 2, 120 0 ± 0 2 and 123 6 ± 0 4 Samples of about 15 mgm in the form of cylinders 1 cm long cast in silica tubes were used, and transitions were studied (*a*) by observing the magnetic moment in a constant small magnetic field (2 gauss) as the temperature was lowered, and (*b*) by measuring magnetization curves at constant temperatures The magnetic moments were measured by a ballistic method[1], and to improve relative accuracy all three samples were studied together The transitions were sharp (~ 0 01° K width), and the transition temperatures ($T_c$), defined as the temperatures (extrapolated to zero field) at which the ratio of magnetic moment to field had half its superconducting value, could be determined with a precision of order 0 001° K relative to each other The values of $T_c$ expressed on the 1949 scale[2] were .

| $M$ | 116 2 | 120 0 | 123 6 |
|---|---|---|---|
| $T_c$° K | 3 763 | 3 707 | 3 654 |

Maxwell's[3] value $T_c = 3\ 662$° K for an enriched sample with $M = 123\ 1$ lies well on a graph of these results, and so too does the value $T_c = 3\ 726$° K for natural tin[4] ($M = 118\ 7$) A log–log plot shows that our results are consistent with the relation $T_c \propto 1/M^{1/2}$, but until the atomic weights have been determined more precisely, a departure of the exponent by as much as 0 05 from ½ is not excluded. This relation was predicted by the theories of Frohlich[5] and Bardeen[6], and has already been verified in experiments on mercury isotopes[7,8] By direct measurements of differences ($\Delta H_c$) of critical field ($H_c$) between two isotopes at the same temperature, it was established that the $H_c-T$ curves are geometrically similar , in particular, the value of $\Delta H_c/H_c$ extrapolated to 0° K was found equal within 5 per cent to $\Delta T_c/T_c$, so that the relative change of electronic specific heat cannot exceed 5 per cent of the relative change of mass The value of $dH_c/dT$ at $T = T_c$ was 142 gauss/° K , and the value of $H_c/T_c$ extrapolated to $T = 0$° K was 81 5 gauss/° K for all three isotopes.

Full details of these experiments will be published later

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THE superconductivity of three samples of separated tin isotopes (identical with those mentioned in the preceding communication) has been investigated with two different methods In addition to some experiments on the magnetic susceptibility, similar to those carried out by the American authors[1] and in Cambridge, detailed measurements of the dependence of the electrical resistance on temperature and magnetic field have been made Thin rolled strips of the three isotopes and of natural tin, which had been annealed, were investigated simultaneously by the same method as employed previously[2] The following results were obtained

| | | | | |
|---|---|---|---|---|
| $M$ | 116 2 | 118 7 | 120 0 | 123 6 |
| $T_c$ ($H$ = 0) | 3 764 | 3 727 | 3 710 | 3 653° K |
| $T_cM^{1/2}$ | 4057 | 4061 | 4064 | 4061 |
| $H_c$ (3 5° K ) | 39 | 35 | 32 | 23 gauss |
| $H_c$ (3 0° K ) | 108 | 104 | 98 | 90 ,, |
| $H_c$ (2 5° K ) | 169 | 166 | 160 | 151 ,, |
| $H_c$ (2 0° K ) | 220 | 216 | 210 | 202 ,, |
| $H_c$ (1 5° K ) | 259 | 255 | 248 | 241 ,, |
| $H_c$ (0° K ) | (308) | (305) | (299) | (291) ,, |
| $H_c$(0° K.)/$T_c$ | 81 8 | 81 9 | 80 5 | 79 9 gauss/deg |
| $dH_c/dT$ ($T_c$) | 152 | 163 | 157 | 154 ,, |
| $R_{4\ 2}/R_{90}$ | 5 × 10⁻³ | 2 5×10⁻³ | 1 5×10⁻³ | 2 × 10⁻³ ,, |

$M$ is atomic weight , $T_c$ is transition temperature in zero field , $H_c$ is critical field , $R_x$ is resistance at $x$° K

As predicted by Frohlich's theory[3], the product $T_c M^{1/2}$ is a constant The high purity of the samples is indicated by the low value of the resistivity at 4 2° K ($R_{4\ 2}/R_{273} \sim 5 \times 10^{-4}$), as well as by the shape of the $H_c$—$T$ curves Below 3° K the latter are similar parabolas to a high degree of accuracy ($\sim$ 1 part in 300), while above this temperature deviations from the parabolic form become significant In this non-parabolic region there also occur slight changes in the relative position of the $H_c$—$T$ curves, the positions being, however, rigorously maintained below 3° K This shift, which may be due to a secondary effect, requires further investigation

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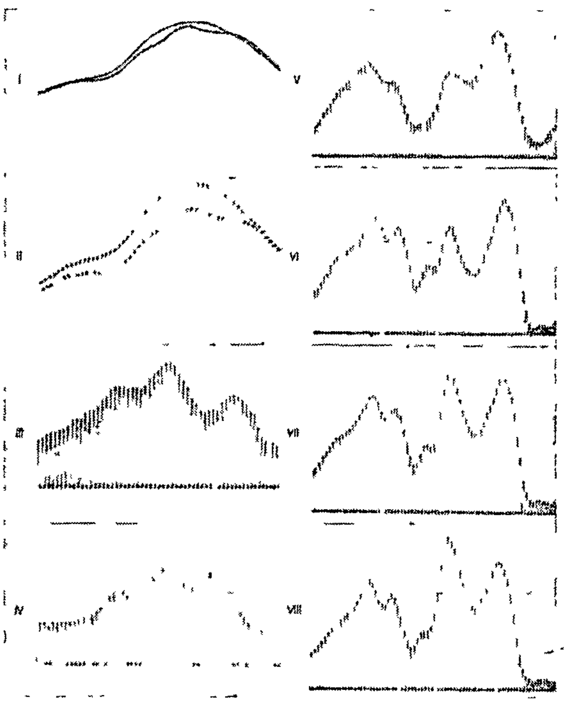
# A Double-beam Infra-red Spectrometer with Fast-Scanning Cathode-Ray Tube Display

IN the past few years, several workers have shown[1-5] that infra-red spectra can be presented continuously on a cathode ray tube The presentation of spectra in this way, in scan times as short as several milliseconds, appears to lend itself to the study of rapid chemical reactions and other transient phenomena In such an investigation of liquid phase reactions, I encountered difficulty in interpreting spectra owing to frequent superposition of bands of the several molecular species involved To minimize this difficulty, a spectrometer has been designed in which, by a time-sharing double-beam system, spectra giving the percentage difference in absorption between two liquid samples can be displayed as an apparently steady trace on a cathode ray tube

Two parallel images of a Nernst glower, about 15 mm apart, are made to fall approximately radially on the teeth of a rotating sector disk This has 20 teeth, with an equal tooth- and gap-width of 15 mm , and is rotated at 6,000 r p m , thus allowing the light beams forming the two images to pass the disk alternately with a switching frequency of 2,000 c /s The two beams are combined by means of an optical mixing device to give a single image, at the entrance slit of the monochromator Cells containing liquid samples can be inserted in the beams just before they reach the chopping disk A Littrow spectrometer arrangement with off-axis paraboloid is used, scanning being accomplished by inserting a small moving plane mirror in the beam between the entrance slit and collimating mirror This plane mirror is mounted on a robust galvanometer coil with strip suspension, the system having a response flat to 100 c /s A sawtooth wave-form at some frequency between 5 and 25 c /s is applied to the coil, giving the mirror a constant angular velocity during the scan, and also to the cathode-ray tube $X$-plates, providing a synchronized time-base for displaying the spectrum A photo-electric system provides angular calibration of the scanning mirror

The detector is a lead sulphide cell which feeds a battery-operated head amplifier of high input impedance and band-width 2 c /s –10 kc /s The signa when the chopping disk is stopped in one positio consists of a series of pulses the tops of which ar modulated by the changes of energy as the spectrometer scans the spectrum, separated by gaps produced by inserting a shutter in the radiation stream during the flyback When the chopping disk is running, there is a ripple at optical switching frequency (2 kc /s ) superimposed on the video pulses and corresponding to the energy difference betwee beams For percentage absorption presentation thi signal is first used to modulate a 200 kc /s carrie which is set to zero amplitude between video pulses This modulated carrier is then adjusted to constan peak level by an amplifier in which the automati gain-controlling voltage is filtered by a circui attenuating the optical switching frequency (2 kc /s but passing Fourier components of the video signa corresponding to absorption bands (up to 200 c /s ) If the energy of the sample beam never exceeds tha of the reference beam, the operation of bringing th peak carrier amplitude to a constant value correspond to standardizing the reference beam By rectifyin and smoothing the carrier output a 2 kc /s rippl component can be recovered which corresponds i amplitude to the percentage difference between th sample and reference beams This is displayed on blue-screen cathode ray tube from which records ar



I. Video traces for water and water + 10 per cent acetone (successive exposures)
II Video trace showing switching between water and water + 10 per cent acetone
III Percentage absorption of acetone at 10 per cent concentration in water (5 per cent peak absorption)
IV Percentage absorption of pure acetone (50 per cent peak absorption)
V Percentage absorption difference between (i) 20 per cent N methyl morpholine, 20 per cent dibenzyl phosphite and 60 per cent ethyl alcohol , and (ii) 40 per cent carbon tetrachloride and 60 per cent ethyl alcohol
VI–VIII Percentage absorption difference between (i) 20 per cent N methyl morpholine 20 per cent dibenzyl phosphite, 20 per cent carbon tetrachloride and 40 per cent ethyl alcohol , and (ii) 60 per cent carbon tetrachloride and 40 per cent ethyl alcohol, at 230, 1,020 and 1,930 seconds after start of reaction

Scans are of 40 m sec duration, I–IV covering the range 1 5–2 μ and V–VIII the range 2–2 5 μ, with longer wave-lengths on left made on fast bromide paper using an electrically operated aircraft camera and an electronic trigger to brighten selected scans.

Performance is at present limited by imperfections of the order of 10 μ in the form of the chopping disk, which shows change-over disturbances varying from tooth to tooth, and by the fact that imperfections in cells and optical mixer prevent the attainment at the spectrometer entrance slit and at the collimator, of radiation distributions identical for both beams These set a limiting error in observing differences, over a normal scan, of 2 per cent of the total transmission From traces I–IV reproduced here, it is seen that a recognizable spectrum (subject to solvent–solute interaction) of acetone in water is obtainable, the peak absorption difference being 5 per cent Similarly, traces V–VIII (peak absorption difference 10 per cent) show that a chemical reaction in which the total change of transmission at the relevant absorption maximum is less than 5 per cent can be readily followed, but that extensive deviations from Beer's law may be the rule

This work was carried out during the tenure of an I C I fellowship at the Department of Colloid Science, Cambridge I am indebted to Messrs. Unicam Instruments (Cambridge), Ltd , who built the spectrometer, and to the Institute of Petroleum for their support of the work

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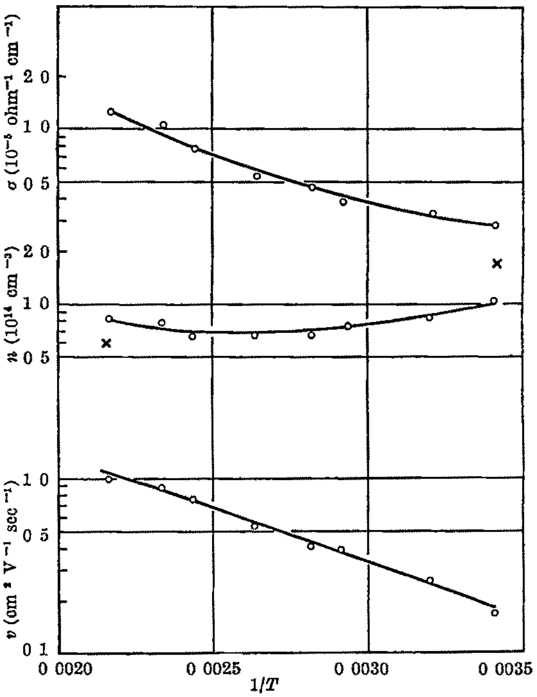
## Hall Effect in a Selenium Single Crystal

IN a recent communication[1], measurements of conductivity and thermo-electric power of selenium single crystals were reported These have now been supplemented by a determination of the Hall effect on one such crystal An A C method of measurement was used in which direct current was passed through the specimen held in a magnetic field alternating at 80 c /s This was found necessary in order to reduce the noise-level below that of the signal

Both the Hall effect and the thermo-electric power ($\theta$) yield values for the concentration ($n$) of free electrons (or positive holes), the formula giving $\theta$ in terms of $n$ and $T$ being[2]

$$\theta = \frac{k}{e}\left(2 + \log \frac{2(2\pi mkT)^{3/2}}{h^3} - \log n\right)$$

A preliminary interpretation of the previous results of thermo-electric measurements along these lines yielded the rather surprising result that $n$ is constant or even falls with increasing temperature, while the conductivity rises in the usual exponential manner The Hall effect measurements, giving an independent value of $n$, have now confirmed this result, at least qualitatively Thus, it appears that in selenium crystals the conductivity varies by virtue of the mobility rising exponentially with increasing temperature, while the value of $n$ remains substantially constant The accompanying diagram shows the conductivity $\sigma$, carrier concentration $n$ (from Hall effect) and the derived mobility $v$ plotted on logarithmic scales against $1/T$. The values of $n$ obtained from the thermo-electric power are represented by the two crosses (The experimental error in the $n$ and $v$ values by Hall effect and by thermo-electric power is about the same, ± 25 per cent )



$\sigma$, $n$ and $v$ for a selenium crystal, current parallel to *c*-axis , ×—×—, values from thermo-electric power

The very low mobility and its variation with temperature support the hypothesis of internal barriers put forward by Muller[3] to account for the deviations from Ohm's law observed with selenium crystals

Henkels[4] has recently published thermo-electric measurements on selenium and values of $n$ and $v$ derived from them These are in agreement, well within an order of magnitude, with the results obtained here

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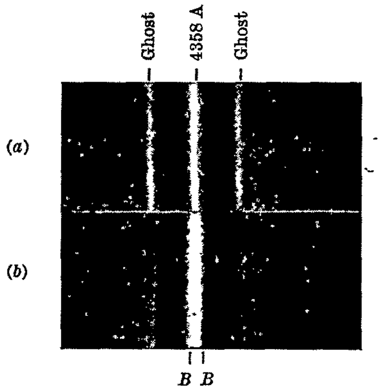
## Brillouin Components in Light Scattered by Quartz

IT was first observed by Gross[1] that, when the 4358-A line of mercury scattered by quartz is examined with a 30-step echelon grating, the line is found to be split up into a doublet, each component being shifted from the centre of the line by 0 18 A He reported later[2] that the line is split up into six components Krishnan and Chandrasekharan[3] have recently studied the structure of the 2536 5-A line of mercury scattered by quartz and filtered through mercury vapour, using a 3-metre quartz spectrograph having a dispersion of 13 cm⁻¹ per mm in this region They have observed a weak doublet, each component of which is shifted from the centre of the line by different amounts for different settings of the crystal With the direction of incidence along the $Y$-axis and scattering along the $Z$-axis of the crystal the shift is 1 90 $cm^{-1}$ This shift is too large to be accounted for by the difference in the refractive indices for 4358 A and 2536 A The intensity of the displaced components is also only a small fraction of that of the undisplaced line Hence these results are not in agreement with those observed by Gross

In order to find out the cause of this discrepancy, the investigation has been repeated with a technique in which the mercury vapour filter has been dispensed with The 4358-A line of mercury incident along the $Y$-axis of a quartz crystal of dimensions 3 cm × 2 5 cm × 5 cm and scattered along the $Z$-axis has been photographed in the third-order spectrum produced by a 12-ft concave grating having a dispersion of 1 5 A per mm and a resolving power of about 40,000 The spectrogram is reproduced herewith The 4358-A line is accompanied by strong ghost lines on each side , but it can be clearly seen that each of these lines consists of a doublet without any central component between the two outer components Thus the incident line is split up into only two Brillouin components during the process of scattering by quartz



(a) Incident, (b) scattered B, Brillouin component

The shift of each component from the centre of the line is 0 179 A or 0 95 $cm^{-1}$ The refractive indices of quartz for the two wave-lengths 4358 A and 2536 A are 1 55 and 1 60 respectively Hence the expected shift in the region of 2536 A is 1 68 $cm^{-1}$ Krishnan and Chandrasekharan have observed only a weak doublet, each of the components being shifted from the centre of the 2536 5-A line by 1 90 $cm^{-1}$ Evidently, the main Brillouin components in their arrangement have been absorbed by the mercury vapour filter, and the larger frequency-shift of the weak doublet observed by them may have been produced by some scattering process in the absorbing mercury vapour observed previously by one of us[4] Thus the method used by them is not suitable for studying the Brillouin components

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## Use of Coaxial-Cylinder Viscometers and Capillary-Tube Viscometers for Suspensions

WHEN a capillary-tube viscometer is used for determining the apparent viscosity of a suspension of discrete, solid particles in a liquid, it is found that the measured viscosity varies with the bore of the capillary, increasing with increasing diameter This effect, termed the sigma phenomenon, has been investigated by several workers, but in particular by Vand[1] and de Bruijn[2], both of whom examined the rheological properties of suspensions of spherical glass particles in liquids inert to glass

Vand, in a mathematical treatment of the problem, suggested that at the wall of the tube through which a suspension is flowing there would be a layer of the liquid phase having a thickness dependent only upon the particle diameter of the solid phase Under certain conditions, therefore, the thickness of the layer would constitute a substantial proportion of the radius of the capillary, and the flow of this liquid film would give rise to the observed effect

De Bruijn attributed the sigma phenomenon to the interaction of particles in a suspension subjected to shear Dix and Scott Blair[3] had proposed a theory in which they assumed that the streamlining layers were not infinitely thin, and that flow took place by the telescoping of concentric fluid layers of equal thickness Extending this theory, de Bruijn obtained an expression relating the sigma phenomenon to the concentration of the solid phase.

Both theories lead to the conclusion that the effect should also be observed in a coaxial-cylinder type viscometer, resulting in an increase of apparent viscosity with increasing annular-gap widths In the course of extensive investigations of the factors affecting the viscosity of suspensions (the results of which will be published in full elsewhere), we have made measurements on stable suspensions of closely sized, spherical, methyl methacrylate polymer particles, having mean diameters varying from 38 to 388 microns, in an aqueous solution of lead nitrate and glycerol Apparent viscosities were determined in a Couette-type viscometer, using annular gaps of 2, 3 and 4 mm , up to volume concentrations of 20 per cent

Within the range investigated (ratios of annular gap to particle diameter from 5 1 to 110 1), no sigma phenomenon was detected, and in all cases the viscosity was independent of the rate of shear The latter characteristic has already been noted when measuring the viscosity of similar suspensions using a rising-sphere viscometer[4], but the fact that the apparent viscosity is independent of gap width in a Couette-type instrument appears to be new The reason for, and the significance of, this observation are not immediately clear, but it leads to the possible conclusion that coaxial cylinder viscometers are to be preferred to capillary-tube viscometers for measurement of the viscosity of stable suspensions

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## The New Einstein Theory and the Equations of Motion

The new Einstein[1] theory is mathematically attractive, but its role in science can only be established through the conclusions that can be drawn from it Einstein himself hopes that his new theory will turn out to be a real field theory, that is, he believes that his equations possess solutions free from singularities and representing particles To show that such solutions exist (or that they do not) s a difficult task But we can ask a simpler question Does the new Einstein theory give equations of motion which are consistent with experience ? That s, do we obtain, in the first approximation, the Lorentz equations of motion ?

In a series of papers[2], the problem of motion, as determined by the field equations alone, was investigated according to general relativity theory. The same method in principle, though with some appropriate changes, can be applied to Einstein's new theory Unfortunately, the equations of motion remain Newtonian and are uninfluenced by the electromagnetic field

Yet it is possible that this negative result is no fault of Einstein's theory, but of the conventional interpretation by which it was derived Indeed, the derivation is based on the assumption that far from the 'centre' of a particle the symmetric part of the metric tensor characterizes the gravitational field, and the antisymmetric part the electromagnetic field

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## Reduction of some Cyclic Amides by Lithium Aluminium Hydride

On reduction by lithium aluminium hydride, amides usually give amines[1] it has now been found that N-methyl phenanthridones behave rather differently, yielding quaternary (phenanthridinium) compounds Phenanthridones are reduced to phenanthridines. Thus, N-methyl phenanthridone and N,3-dimethyl phenanthridone (m p 139°, found C, 80 6, H, 5 8, N, 6 15 per cent, calc for $C_{15}H_{13}ON$ C, 80 7, H, 5 8, N, 6 3 per cent) reduced in ethereal solution on the 300-mgm scale gave respectively 60 and 55 per cent yields of the quaternary iodides (3-methyl phenanthridine methiodide, m p 278°, found C, 53 8, H, 4 1, N, 4 5, I, 37 4 per cent, calc for $C_{15}H_{14}NI$ C, 53 75, H, 4 2, N, 4 18, I, 37 9 per cent) The analogous N-methyl quinolone likewise gave N-methyl quinolinium chloride (identified as its platinichloride), but the reaction was less easy, two hours refluxing in dibutyl ether giving a 20 per cent yield Among the reduction products of N-methyl pyridone, only a trace of quaternary compound (isolated as picrate) was found, together with methylamine (7 per cent isolated as the platinichloride)

Phenanthridone and 1-methyl phenanthridone (m p 240°, found C, 80 0, H, 5 3 per cent, calc for $C_{14}H_{11}ON$ C, 80 4; H 5 3 per cent) reduced on the 100-mgm scale gave respectively 70 and more than 50 per cent yields of the corresponding phenanthridines no precautions were taken to prevent air-oxidation of any dihydro derivative which was formed[2]. 2-Hydroxy quinoline reduced (6 hr ) in boiling dibutyl ether gave quinoline (26 per cent as the picrate) and, isolated chromatographically, tetrahydroquinoline (5 per cent as the benzoyl derivative) , 2-hydroxy pyridine similarly gave pyridine (8 per cent as the picrate) and piperidine (1 5 per cent as the *p*-toluenesulphonyl derivative) Pyridine refluxed in dibutyl ether with lithium aluminium hydride for 3 hr gave a 10 per cent yield of piperidine (isolated as the *p*-toluenesulphonyl derivative), no unchanged pyridine being recovered

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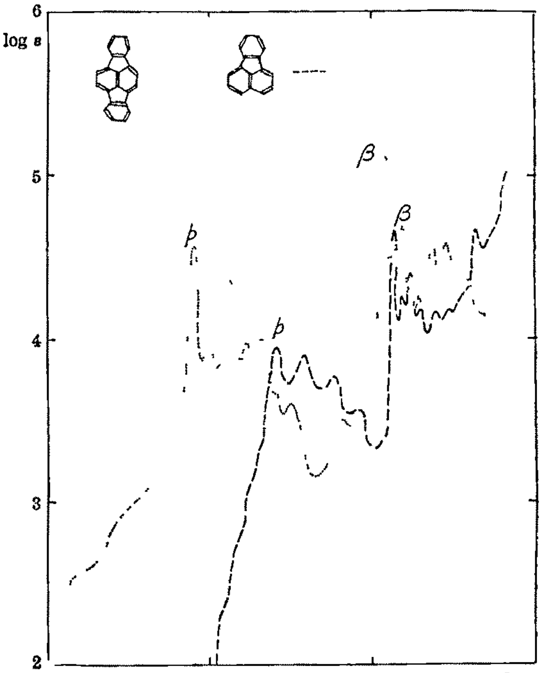
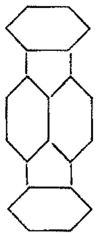
## *bis-peri*-Phenylenenaphthalene

*bis-peri*-Phenylenenaphthalene (I) has been synthesized, and the preparation will be described (by H W D S and S H T) in a forthcoming communication

We describe herein the ultra-violet absorption spectrum of this hydrocarbon. In the accompanying graph its spectrum is superimposed on that of fluoranthene The *p*-bands[1] are clearly separated from β-bands[1], but the general similarity of the curves is so great that one may say that (i) the



Absorption spectra of *bis-peri*-phenylenenaphthalene ( ) and of fluoranthene (– – – –) in ethanol Band maxima (in A ), *bis-peri*-phenylenenaphthalene *p*-bands 4100, 4020, 3870, 3795, 3670, 3490 β-bands 2925, 2865, 2810, 2760, 2705 β′-bands 2625, 2530 Fluoranthene *p*-bands 3585, 3420, 3230, 3090 β-bands 2870, 2820, 2760, 2715, 2615, 2525, 2450 β′-bands 2360



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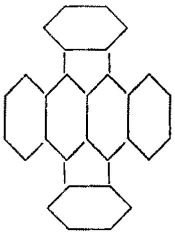

II

pronounced resemblance in fine structure of the β-bands indicates a close electronic relationship between the two hydrocarbons, (ii) the very small shift in wave-length of the β-band group of *bis-peri*-phenylenenaphthalene in relation to that of fluoranthene is probably due to almost complete lack of interaction of the π-electrons of one phenylene ring-system with those of the other, (iii) on the other hand, the *p*-bands of *bis-peri*-phenylenenaphthalene are shifted considerably towards the red end of the spectrum

It is of interest to compare these spectra with that of 5 6 11 12-diphenylenetetracene (II)[2] The first *p*-band in the spectrum of (II) occurs at 6100 A, whereas that of *bis-peri*-phenylenenaphthalene (I) is at 4100 A, this shift corresponds to an increase of about two anellation units[3], thus harmonizing with the relative data for naphthalene and tetracene It follows that *p*-absorption in *bis-peri*-phenylenenaphthalene and in fluoranthene is located in the naphthalene and in (II) in the tetracene ring system present in these hydrocarbons

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# Permanganate as a Spraying Reagent for Amino-acids on Paper Chromatograms

POTASSIUM permanganate (1 per cent solution, containing 2 per cent sodium carbonate) has been recommended[1] as a spraying reagent for detecting carbohydrates on paper chromatograms When testing this reagent on a chromatogram irrigated with butanol/acetic acid and carrying amino-acids as well as carbohydrates, an anomalous spot was observed, which was traced to methionine It has now been found that if a paper chromatogram be lightly sprayed with the permanganate reagent, methionine, tryptophane, tyrosine and (more weakly) proline and histidine immediately appear as yellow spots on a red background As the paper dries the colour difference tends to disappear, leaving the spots and background different shades of brown The spots should therefore be marked at once Cysteine also gives a spot, but does not normally occur on a paper chromatogram[2] Threonine, hydroxyproline, lysine and glycine show up on standing a few minutes Other amino-acids normally occurring in protein hydrolysates do not show at the concentrations encountered in paper chromatography

The reaction is especially sensitive to methionine, and may be of value as a confirmatory test for this amino-acid The reagent is not applicable when phenol has been used as irrigating solvent

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# Electrolytic Detection of Alkali Salts on Filter Paper

SINCE the work of Lederer[1] and Arden *et al*[2], the separation of inorganic cations by paper chromatography has been developed rapidly The alkali salts, however, do not appear to have been studied, because of the difficulties of detection of alkali cations on the filter paper We have recently discovered a simple electrolytic method of detecting the alkali and alkaline earth cations, and have studied the paper chromatography of the alkali salts

The principle of this method is the cathodic production of alkali hydroxides by the electrolysis of aqueous solutions of alkali salts The procedure is as follows The paper strip is dried to drive off the developing solvent, and the saturated alcohol/water solution (1 1) of phenolphthalein is sprayed on it Then the paper is electrolysed by D C (6 V, about 5 sec), being held between flat graphite electrodes (cathode upper) A red spot indicates the existence of alkali salts The limits of detection with this method are tabulated in the accompanying table.

LIMITS OF DETECTION OF POTASSIUM CHLORIDE

| | Developing solvent | Distance of migration | Limits of detection |
|---|---|---|---|
| Before development | | | $1\gamma/10^{-3}$ ml |
| After development | Butanol + ammonia | 1 cm | $5\gamma/10^{-3}$ ml |
| | Butanol + acetic acid | 6 cm | $10\gamma/10^{-3}$ ml |

The values in the table show that this method can be applied satisfactorily to the chromatography of alkali salts, but the small amount of acid that cannot be removed by drying the paper reduces the sensitivity

Some results so far obtained are as follows (1) Filter paper for qualitative analysis (Tōyō Roshi, No 2) is unsuitable for the chromatography of alkali salts, because it contains considerable amounts of these salts For this reason we use quantitative analysis filter paper (Tōyō Roshi, No 3) in our experiments. (2) Although the lithium ion is easily separated from other alkali ions, the separations of other ions are very difficult with ordinary solvents (3) Potassium chloride is easily separated from iodide with butanol/acetic acid solvent Chromatographic analysis of the anions of alkali salts will be possible by selecting suitable solvents

We are now studying the separations of the alkali cations and various anions with this method

We wish to acknowledge the suggestion of Prof T Titani

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## Use of 'Amberlite *IRC*-50' for the Partial Purification of a Bacterial Pectinase

In the course of an investigation of the pectolytic enzymes of certain plant pathogens, it was found possible to effect a partial purification of bacterial pectinase with a cation exchange resin, 'Amberlite *IRC*-50'

A separation of pectinesterase and polygalacturonase with 'Amberlite *IR*-100' has been reported by McColloch and Kertesz[1], though the validity of their method has been questioned by Lineweaver, Jang and Jansen[2] Their objection to the use of Amberlite *IR* 100, namely, the development within the column of rather low *p*H values (*p*H 1 0–2 0), was eliminated in the present investigation by using 'Amberlite *IRC*-50', which is a weak-acid cation exchanger readily buffered at any desired *p*H value over a wide range

The pathogen, *Bacterium aroideæ*, was grown in a liquid medium of the following composition glucose 1, peptone 0 5, potassium dihydrogen phosphate 0 08, magnesium sulphate 0 03, calcium carbonate 1 0, water to 100 per cent After five days, the culture fluid was centrifuged at 4,000 r p m for 20 min to remove most of the bacteria, excess carbonate, etc , and the *p*H adjusted to 7 6

A suspension of the sodium-salt form of the resin was treated with *N*/10 hydrochloric acid to bring the *p*H to 7 6–7 8, and then allowed to settle as a sediment to form a column 20 cm × 1 cm The system was such that no further buffering was required

In a typical test, 50 ml of centrifuged culture filtrate was passed through the column at an effluent rate of about 1 25 ml /min After thorough washing of the column with distilled water, the adsorbed enzyme was eluted with 15 ml of *N*/10 hydrochloric acid, the effluent rate being 1 0 ml /min , and the *p*H of the effluent about 6 2–6 4 It should be pointed out that though *N*/10 acid is used as an elutant, it is rapidly neutralized by exchange with sodium ions from the resin, and in view of the slow rate of flow, the *p*H of the major part of the column probably does not fall below 6 0 Sodium chloride was removed from the enzyme solution by dialysis through 'Cellophane' 1 ml of the dialysed solution caused complete hydrolysis of 5 ml of 1 per cent sodium pectinate solution in 15 min This was of the same order as a dialysed preparation of the crude culture fluid, so that although considerable quantities of impurities are removed in the process there is an appreciable loss of pectolytic enzyme

Further details of the investigation are to be published elsewhere

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## Reduction by Molecular Hydrogen of Acetoacetate to Butyrate by Butyric Acid Bacteria

Stadtman and Barker[1,2], working with extracts of *Cl kluyveri*, and Cohen and Cohen-Bazire[3–5], using suspensions of butyric acid bacteria, found that acetoacetate is split into two $C_2$-carbon residues These workers found acetate from acetoacetate, whereas Stadtman and Barker observed a phosphoroclastic splitting of acetoacetate to acetate and acetyl phosphate It should be noted that the suspensions utilized by Cohen and Cohen-Bazire possess strong acetyl phosphatase activity Nisman[6], utilizing extracts of the same bacteria obtained by ultrasonic vibration, finds that pyruvate yields considerable amounts of acetyl phosphate

The reverse reaction, that is, the synthesis of acetoacetate from acetate and acetyl phosphate, has been postulated by Lipmann[7] as a step in the synthesis of butyrate from pyruvate Stadtman and Barker[2], in an attempt to achieve this reaction, find only small but none the less significant amounts of a β-keto acid which they think to be acetoacetic acid β-Keto acid accumulates in greater quantity in presence of 0 002 *M* hydrogen cyanide Incubation of extracts of *Cl kluyveri* with acetate, acetyl phosphate and hydrogen leads to a synthesis of butyrate[8], whereas acetoacetate incubated with hydrogen under the same conditions gives rise, almost mole per mole, to β-hydroxybutyrate, which is not further metabolized, and to traces of butyrate In view of these results, Stadtman and Barker[2] come to the conclusion that acetoacetate is not a precursor of butyrate This assumption is supported by further experiments conducted by the same workers with carbon-14 labelled compounds

On the other hand, we[4,5] have shown that suspensions of butyric acid bacteria may utilize lactate or pyruvate as hydrogen donors for the transformation of acetoacetate to butyrate With 'deficient' suspensions[9], pyruvate or acetoacetate alone give rise only to acetate , simultaneous incubation with both pyruvate and acetoacetate leads to the formation of butyrate In view of Stadtman and Barker's experiments, it was interesting to study the reduction of acetoacetate by molecular hydrogen Since we have found β-hydroxybutyrate to be fermented *in vacuo* to acetate and butyrate[5,10], we have also studied its behaviour in a hydrogen atmosphere Our results are summarized in Table 1

It is seen from these results that, contrary to what occurs *in vacuo*[5,10], β-hydroxybutyrate is not metabolized in an atmosphere of hydrogen This is consistent with Stadtman and Barker's observations In

Table 1 Suspensions are prepared as previously described (ref 9) Each Warburg vessel contained in the main part phosphate buffer *M*/45, substrate and water to adequate volume , 0 2 ml 20 per cent potassium hydroxide in the central well , 0 5 ml bacterial suspension in the side bulb Total volume 3 2 ml Suspension and substrate are mixed after 15 min equilibration Temperature 37° C , *p*H 7, gas phase, hydrogen The data have been corrected for hydrogen absorption of the suspension alone The results are expressed in micromoles

| Strain | Aceto-acetate | | Δ Aceto-acetate | Hydrogen | β-Hydroxy-butyrate | |
|---|---|---|---|---|---|---|
| | Initial | Final | | | Initial | Final |
| *Cl aceto-butylicum PC48* | 43 | 0 | 43 | 32 | — | 11 3 |
| ,, | — | — | — | 0 | 13 7 | 13 5 |
| *Cl saccharo-butyricum GR4* | — | — | — | 0 | 13 7 | 13 4 |

Table 2. Strain *PC*48. Same conditions as in Table 1. Sodium arsenite, *M*/300. When volatile acid determinations were done, the experiments were run in a series of six to eight vessels. Since the consumption of hydrogen was identical in the different vessels, the various determinations were made on a pooled sample. The data have been corrected for hydrogen absorption, butyrate and acetate formation of the suspension alone. The results are expressed in micromoles

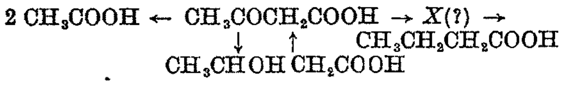
| | Number of vessels | Acetoacetate | | Hydrogen | β-Hydroxybutyrate formed | Butyrate formed | Acetate formed | Hydrogen / Acetoacetate | Butyrate / Acetoacetate | Hydrogen / Butyrate |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Initial | Disappeared | | | | | | | |
| I | | | | | | | | | | |
| Without As | 8 | 344 | 344 | 208 | 104 | 50 | 300 | 0.6 | 0.14 | 4 |
| With As | 8 | 344 | 184 | 264 | 8 | 144 | 10 | 1.4 | 0.78 | 1.8 |
| II | | | | | | | | | | |
| Without As | 1 | 43 | 43 | 28 | 10 | — | — | 0.65 | — | — |
| With As | 6 | 258 | 246 | 432 | 6 | 200 | 40 | 1.75 | 0.81 | 2.1 |

the case of acetoacetate, 25–30 per cent is reduced to β-hydroxybutyrate; this also agrees with the results of these authors. Most of the remainder is split to acetate, while a small amount only is reduced to butyrate (see also Table 2). The possibility cannot be excluded, at least with the 'normal' suspensions[9], that this small amount of butyrate is not derived from a previous splitting of the acetoacetate followed by a recondensation of two $C_2$ residues to another $C_4$ intermediary compound. This is less probable with the 'deficient' suspensions, which are unable to produce butyrate unless a $C_4$ compound is available.

Sodium arsenite (*M*/1,000) inhibits the splitting of acetoacetate to acetate by suspensions of the butyric acid bacteria[5]. On the other hand, while the ratio of butyrate to acetate produced from β-hydroxybutyrate *in vacuo* remains unchanged in its presence, this inhibitor reduces considerably the total volatile acids produced from this substrate. By raising the concentration of arsenite to *M*/300, we have found it possible to inhibit almost completely the fermentation of β-hydroxybutyrate. The latter is fermented *in vacuo* by the intermediary of acetoacetate, the suspensions possessing an active β-hydroxybutyric dehydrogenase[11].

In the transformation of acetoacetate to butyrate, these two actions of arsenite allow us to discount the possibility of a preliminary splitting to acetate. Actually, in the presence of *M*/300 arsenite and acetoacetate: (*a*) the ratio of hydrogen consumed to acetoacetate metabolized is more than doubled; (*b*) traces only of β-hydroxybutyrate are produced; (*c*) practically no splitting of acetoacetate occurs and butyrate is the main, if not the only, product of the reaction.

The data in Table 2 show these results, which are visualized by the following scheme:



$$\begin{array}{l} 2\,CH_3COOH \leftarrow CH_3COCH_2COOH \rightarrow X(?) \rightarrow \\ \qquad\qquad\qquad\quad \downarrow\ \uparrow \qquad\quad CH_3CH_2CH_2COOH \\ \qquad\qquad\quad CH_3CHOHCH_2COOH \end{array}$$

In the absence of arsenite, three reactions compete for the utilization of acetoacetate: splitting to acetate, reduction to β-hydroxybutyrate, and reduction to butyrate.

The above results demonstrate that in the presence of arsenite the two first reactions are inhibited, two moles of hydrogen being utilized per mole of butyrate produced. The overall reaction in the presence of arsenite is

$$CH_3COCH_2COOH + 4\,H \rightarrow CH_3CH_2CH_2COOH + H_2O$$

This reduction may involve an intermediate in the same state of oxidation as β-hydroxybutyrate, this compound itself being definitely excluded as an intermediate in butyric acid synthesis by the organisms utilized in this study.

*In vacuo*, the reaction $CH_3COCH_2COOH \rightarrow CH_3CHOHCH_2COOH$ proceeds towards the left, while in an atmosphere of hydrogen the equilibrium is shifted to the right and β-hydroxybutyrate is not fermented.

These results, while not allowing us to state with any assurance whether acetoacetate is actually an intermediate in butyric acid synthesis, nevertheless show that it can be reduced directly to butyrate and make it worth while to re-investigate the problem more closely.

A detailed paper will be published elsewhere.

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Garches (Seine et Oise). Aug. 24.

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## Energetics of Uterine Muscle Contraction

LUNDSGAARD[1] has shown that the energy liberated by striated muscle, poisoned by monoiodoacetic acid under anaerobic conditions, is proportional to the breakdown of creatine phosphate. He has also shown that under these conditions adenosinetriphosphate[2] also disappeared on stimulation. In view of these facts, and Lohmann's[3] findings on the phosphate transfer between creatine phosphate and adenine compounds, it can be assumed that adenosinetriphosphate and creatine phosphate together form the store of immediately available energy in muscle. According to Lundsgaard, a muscle poisoned by monoiodoacetic acid can perform about a hundred contractions in nitrogen. The energy of these contractions is derived solely from the stored high-energy phosphates, which, under normal conditions, are regenerated by carbohydrate metabolism.

It appears of interest to study uterine muscle with the view of establishing the energy requirements of a contraction. Corner and Csapó[4], studying the contraction of uterine strips (sow) after electrical stimulation, observed that inhibition of glycolysis by

PHOSPHORUS FRACTIONS IN UTERINE AND SKELETAL RABBIT MUSCLE
(means with standard errors)

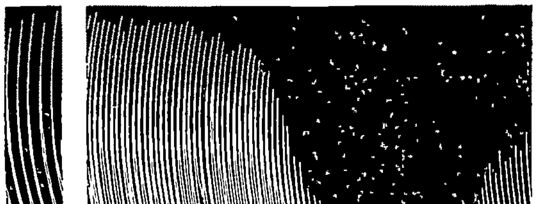
| | Inorg P ($\mu M$/gm wet weight) | CrP ($\mu M$/gm wet weight) | ATP ($\mu M$/gm wet weight) | CrP + ATP ($M$/gm ) |
|---|---|---|---|---|
| Uterus* | 5 17±0 36 | 0 74±0 09 | 1 90±0 09 | 2 64 |
| Skeletal muscle | 10 82±0 79 | 10 50±1 42 | 7 00±0 43 | 17 50 |
| Ratio S/U | | | | 6 63 |

* Five animals in œstrus, three in fifth day of pregnancy Since there was no significant difference between the two groups, the means were calculated from the pooled data

Lohmann (ref 8) has reported one determination of the acid labile phosphorus content of rabbit uterus corresponding to 1 34 $\mu M$ of adenosinetriphosphate per gm , Eggleton and Eggleton (ref 9) have also published the result of one experiment, the values being 1 40 $\mu M$ of adenosinetriphosphate and 0 45 $\mu M$ of creatine phosphate per gm

monoiodoacetic acid together with exclusion of oxygen reduced the number of contractions which could occur before complete exhaustion A chemical study of the high-energy phosphates of uterine muscle together with a quantitative study of the monoiodoacetic acid effect seemed, therefore, desirable The ratio of the amount of high-energy phosphates to the number of contractions with monoiodoacetic acid might indicate the energy requirement of one contraction cycle, and this quantity could be compared with available data on striated muscle

Rabbits weighing about 8 lb were anæsthetized with 'Nembutal', the uteri were quickly removed and frozen in a mixture of dry carbon dioxide and ether Frozen samples of about 0 5 gm were pulverized, weighed and then homogenized with sea-sand in 8 ml of ice-cold 5 per cent trichloroacetic acid The extract was centrifuged at 0° in a refrigerated centrifuge and the supernatant was used for analysis Analyses were made for inorganic phosphate, creatine phosphate, and acid labile phosphorus (9 min boiling in 1 $N$ hydrochloric acid) Phosphate was determined by the method of Fiske and SubbaRow[5] Creatine phosphate was obtained as the difference between the 20-min reading and the extrapolated value at zero time The latter was the value of orthophosphate. Duplicate determinations of inorganic phosphate by precipitation of the calcium salt from the neutralized trichloroacetic acid extract were in satisfactory agreement The results are given in the accompanying table For comparison we have included the results of similar determinations on rabbit psoas muscle We have expressed the labile phosphate as adenosinetriphosphate (1 mole of the latter is equivalent to 2 moles labile phosphate) These results indicate that the amount of readily available energy per gram is considerably smaller in uterine than in striated muscle.



*In vitro* effect of anoxia (upper graph) and anoxia + monoiodoacetic acid poisoning (lower graph) on excised rabbit uterine strips *A*, spontaneous contractions, *B*, electrical stimulation every 30 sec , *C*, oxygen off, nitrogen on, *M*/10,000 monoiodoacetic acid is added to the lower strips, *D*, oxygen on, nitrogen off, bath change for lower strip Time signal, 1 min

The accompanying record shows the result of a typical stimulation experiment in nitrogen with and without monoiodoacetic acid Monoiodoacetic acid considerably reduces the number of contractions the uterus can perform (Similar results were obtained in three experiments on rabbit uterus strips and in four experiments on sow uterus strips ) In view of our finding a smaller amount of high-energy phosphates in uterine muscle, it is interesting to note that in monoiodoacetic acid poisoning there are only about ten contractions in contrast to 70–100 in the case of striated muscle We assume that after exhaustion of the monoiodoacetic acid-treated uterine muscle similar changes occur as in striated muscle, though this point requires further investigation In comparing the energy available in high-energy phosphate bonds with the number of contractions, one has to decide whether to count one or two phosphate bonds for an adenosinetriphosphate molecule

Inspection of Lundsgaard's[2] data shows that in exhausted striated muscles all the creatine phosphate disappears plus about half of what he called pyrophosphate On this basis it seems justifiable to take creatine phosphate plus adenosinetriphosphate in moles as a measure of the available energy The ratio of energy to contractions seems to be of the same order in monoiodoacetic acid-poisoned striated and uterine muscle In terms of high-energy phosphate bonds, it corresponds to about 0 25 $\mu M$/contraction/gm Hill[6] has measured the initial heat of a single striated muscle contraction directly and finds it to be 3 mcal , and from this calculated[7] a value of 0 25 $\mu M$ phosphorus/contraction/gm , which is identical with our result

Thus we have shown that uterine muscle contains about one-seventh of the high-energy phosphates in striated muscle, but the energy requirements for a single contraction appear to be of the same order of magnitude in both muscles A more detailed study is in progress with particular emphasis on the enzymatic determinations of the various nucleotides that may play a part in the energy supply of uterine muscle

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## Epidermal Transplantation during Chemical Carcinogenesis

In the study of the mechanism of epidermal carcinogenesis, it is perhaps not surprising that attention has been mainly directed to the epithelium of the epidermis itself. Nevertheless, changes occur in the dermis and subcutis which can be distinguished from the effects of non-specific irritants, and it has been suggested that these changes are of importance in the carcinogenic reaction[1]. As it is now technically possible to make pure epidermal grafts[2], the opportunity has been taken to test this hypothesis by transferring the epidermis of a carcinogen-treated site to an untreated body-site, and *vice versa*.

Mice were painted with methylcholanthrene (0.3 per cent in acetone) once a week for twelve weeks on the skin of the right scapular region (referred to as the 'treated area'). They were then left untreated for two weeks, the few animals with tumours discarded, and the remainder subjected to one of the following operations.

(*a*) Epidermis removed from treated area, to which tail skin epidermis was transplanted.

(*b*) Epidermal grafts from treated area transplanted to a bed prepared by removing the epidermis from the left dorsal thorax (referred to as the 'grafted area').

(*c*) Thiersch grafts (that is, epidermis and superficial dermis) from treated area transplanted to grafted area (single bed).

(*d*) Thiersch grafts of treated area transplanted to four separate beds in grafted area.

Results of experiments.

(*a*) Of 21 survivors when the first tumour appeared in this group, 12 have developed tumours on the treated area in an average time of 78 ± 17 days after operation.

(*b*) 28 survivors at first tumour: 13 tumours on the treated area in 93 ± 16 days; no tumours on the grafted area.

(*c*) 7 survivors; 4 tumours in 92 ± 45 days (3 of these definitely on the treated area, the other doubtful in position). In addition, one of the mice had a nodule on the grafted area, which had the histological structure of an implantation epidermoid cyst.

(*d*) 8 survivors; 5 tumours in 67 ± 37 days, all on the treated area. No tumours on the grafted area.

The validity of these results obviously depends on the grafts having 'taken' adequately. They appeared to have done so, but it is not yet possible to be as certain on this point in the mouse as it would be in larger rodents. The part played by the hair follicles has to be taken into consideration; the deep parts are necessarily left *in situ* during grafting, while the superficial parts are presumably transferred with the graft. Histological examination does not suggest that a considerable proportion of the tumours originated in hair follicles, and the negative results on the grafted area in experiment (*b*) may be significant.

This work was aided by funds from the Birmingham Branch of the British Empire Cancer Campaign.

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## Estimation of Collagen in Hard Tissues

In analysing the protein constituents of connective tissues, it is usually assumed that collagen is represented by a fraction of the total nitrogen which is precipitable by tannic acid after autoclaving the washed sample. The existing procedure for the determination of this protein in bone[1] was applied to dentine[2], but later shown to be unsatisfactory. Preparation of the powdered sample by grinding results in the conversion of at least one-tenth of the collagen to gelatin. Drastic autoclaving conditions account for the failure to precipitate a similar fraction of the protein thus made soluble, while somewhat more of the gelatin remains adsorbed on the autoclaved dentine powder even after washing with boiling water. These facts became apparent when a purified hide collagen sample[3] was mixed with the correct proportion of the residue prepared by extracting dentine with boiling alkaline ethylene glycol and analysed under the same conditions.

PERCENTAGES OF TOTAL NITROGEN FOUND IN FRACTIONS OBTAINED WHEN SAMPLES ARE WASHED AND THE GELATIN (RELEASED BY AUTOCLAVING) PRECIPITATED WITH TANNIC ACID

| Sample | Soluble in water | Soluble on autoclaving Precipitate | Soluble on autoclaving Filtrate | Adsorbed on residue |
|---|---|---|---|---|
| Dentine collagen | 0 | 91 | 8 | 0 |
| Hide collagen | 0 | 91 | 9 | 0 |
| Dentine collagen* | 0 | 81 | 7 | 12 |
| Hide collagen* | 0 | 82 | 7 | 12 |
| Crushed dentine* | 5 | 65 | 7 | 24 |
| Crushed dentine | 5 | 75 | 8 | 12 |
| Ground dentine | 15 | 66 | 6 | 13 |

* Added to an equivalent quantity of deproteinized dentine.

The fractions thus obtained were then examined after hydrolysis by comparing their amino-acid 'spectra'. These were obtained by using a method[4] which has been applied here to the characterization of proteins: Ninhydrin-developed paper chromatogram strips were passed through a photo-electric colorimeter and the optical densities then plotted against the distances travelled by the amino-acids. Water-soluble protein from crushed dentine was thus shown to be gelatin. Included with the gelatin fraction adsorbed on the residue left after autoclaving was an insoluble protein, amounting to 1 per cent of the total collagen and giving a 'spectrum' which was not typical of collagen, elastin or reticulin; the residue from hide collagen has similarly been differentiated[5].

Further evidence as to the amount of collagen in hard tissues is provided by a method which may have useful applications as it avoids both drying and weighing the samples to be analysed. Convenient volumes of dilute phosphoric acid solutions containing dentine or the isolated collagen were digested with (*a*) sulphuric acid, using a peroxide catalyst, and (*b*) a dichromate – sulphuric acid reagent[6]. From (*a*) the total nitrogen was estimated colorimetrically, and from (*b*) the amount of oxidant consumed was calculated after iodometric titration. The ratio of *a* to *b* was expressed as 'mgm. nitrogen/ml. *N* thiosulphate', and measured the relation between protein and total organic matter. Ratios obtained by analyses on deciduous dentine, on incisor, canine, premolar and molar permanent dentine, varied by less than 1 per cent from their mean, which was definitely less than the single ratio equally applicable to the isolated collagens from dentine, bone and ox hide

It is thus clear that only citric acid (0 9 per cent)[7], mucopolysaccharide (0 2 per cent) and fat (0 2 per cent), which were also estimated, can otherwise be present in significant quantities in dentine

In connexion with this revision, attention may be directed to the widely ignored complaint[8] that incineration procedures as used are misleading if the amount of organic matrix in hard tissues is to be studied The same objection—that combined water is also removed from the 'moisture-free' samples—applies when the organic matter is removed by extraction with alkaline ethylene glycol However, Tomes considered that the combined water was released from the inorganic salts by incineration, whereas the present finding that water retained after drying at 100° is not retained by the residue dried after autoclaving at 120° favours the opinion that it is bound by the collagen All the collagen samples from bone and dentine showed 18 3–18 4 per cent total nitrogen, as did hide collagen, after drying for 2 hr at 100°. Prolonged drying is necessary to obtain the 18 6 per cent reported for hide collagen[3] prepared in the same way as the sample used for this comparison and kindly supplied by Dr. Joane H Bowes of the British Leather Manufacturers' Research Association It is of interest to note that the 19 6 per cent organic matter stated by Tomes[8] to be present in dentine, instead of the 25–28 per cent still generally quoted, is the sum of the 18 per cent collagen and other organic constituents listed here

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## Lepidopterous Eggs and Larvæ from the Exterior of Aircraft Fuselages

ALL aircraft arriving from abroad at Whenuapai Airport, Auckland, New Zealand, are sprayed with an insecticidal aerosol and then searched for insect remains by mosquito control personnel of the Medical Branch of the Royal New Zealand Air Force

During a routine search on May 6, 1950, a number of insect egg masses and emerging larvæ were collected forward of the aerial on the underside of the nose of an R N Z A F Dakota (*DC*3) aircraft, on its arrival from Nausori Airport, Fiji The eggs, most of them containing late embryos, were in aggregations of several hundred, the masses measuring up to 10 mm × 6 mm × 2 mm They are spherical to sub-spherical in shape, the chorion being ribbed and reticulated, and are embedded in a mass of fine hairs The body of the larva is furnished with short setæ, but has no secondary hairs Tubercles vi and vii on the sixth abdominal segment each bears a single seta This segment has well-developed prolegs bearing a number of crochets, the arrangement of which appears to be linear The prespiracular wart on the thorax has two setæ, while in the case of both meso- and meta-thorax tubercle vii is furnished with but one seta Thus, from Chu's key[1], the larvæ, while being of too early a stage for specific identification, appear to belong to the family Noctuidæ (Lepidoptera), which contains many pests of agricultural crops

A further collection of egg masses, the structure of the eggs appearing to be identical with that of those just discussed, was made from beneath the wings of another R.N Z A F Dakota on its arrival at Whenuapai from Nandi Airport, Fiji, on June 10, 1950. Neither emergent larvæ nor late embryos were present in the material forwarded to me for examination In the first instance described above, the aircraft had been on the ground at Nausori for approximately 88 hr , whereas in the second one the machine concerned had been at Nandi for only 40 hr The minimum period elapsing between oviposition and hatching in the case of the moth under consideration is thus between 40 and 88 hr From the fact that only a minority of the eggs collected from the first aircraft had hatched, this period is probably not very far short of 88 hr

Senior White and Kirkpatrick[2] in Trinidad, B W I , and Dumbleton[3] in Aitutaki and Western Samoa, have already recorded lepidopterous eggs as being carried on the exterior of aircraft fuselages. The first-named authors were able to hatch out some of the eggs in the laboratory (estimated interval between oviposition and hatching, about 72 hr ), identifying them as being those of a noctuid moth near *Phytometra* The eggs discovered by Dumbleton resemble those described in the present account in being sub-spherical and in having a sculptured chorion, also in being mixed with fine linear scales or hairs, but the lepidopterous family concerned was not determined

It appears probable that the carriage of lepidopterous eggs on the exterior of aircraft fuselages is of more common occurrence than has previously been suspected From the fact that emerging larvæ were present in the first instance reported from Whenuapai, the suggestion made by Senior White and Kirkpatrick that such larvæ might easily be swept away during flight and thus be deposited over perhaps hundreds of miles of countryside, so rendering possible the establishment of invasion foci, assumes added significance

The use of DDT as a control agent to guard against such contingencies would be of little value, because the insecticide would be liable to be washed away by rain during flight Careful polishing of the whole exterior of aircraft fuselages before take-off would seem to offer the most promising means of control, but such a procedure is not considered practicable. However, at least at those international airports where insect control personnel are available, some measure of control could be achieved by visual inspections of aircraft fuselage exteriors both before the commencement and after the completion of flights

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# FORTHCOMING EVENT

## Thursday, December 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 3 p m —Prof E N da C Andrade, F R S "Waves and Vibrations" (Course of Lectures adapted to a Juvenile Auditory ) (Further Lectures on December 30, January 2, 4, 6 and 9 )

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

EDUCATIONAL PSYCHOLOGIST at the Reigate Child Guidance Clinic—The County Medical Officer, County Hall, Kingston-upon-Thames, Surrey (December 29)

TECHNOLOGIST, Grade I (with a good general training in chemistry, preferably up to degree standard)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1 quoting TT/275 (December 29)

FELLOWSHIPS IN EDUCATIONAL AND CLINICAL PSYCHOLOGY—The National Association for Mental Health, 39 Queen Anne Street, London, W 1 (December 30)

ASSISTANT ADVISORY OFFICER for work in the Grassland Husbandry Department—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (December 31)

CHAIR OF PARASITOLOGY at the University of Malaya—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W C 1 (December 31)

LECTURER IN BOTANY, a SENIOR LECTURER IN AGRICULTURAL CHEMISTRY, a SENIOR LECTURER or LECTURER IN ECONOMICS, and a SENIOR LECTURER IN STATISTICAL METHODS, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (December 31)

PASTURE AGRONOMIST IN THE DEPARTMENT OF VETERINARY SERVICES, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings Great Smith Street, London, S W 1, quoting No 27059/244 (December 31)

PASTURE OFFICER (to advise the Director of Agriculture and Veterinary Services on technical matters relating to pasture control), and SENIOR GRAZING OFFICERS (2, to work under the Pasture Officer), Somaliland Protectorate—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27059/259 (December 31)

CHIEF BIOCHEMIST in charge of the Endocrine Laboratory at Chelsea Hospital for Women—The Secretary, Queen Charlotte's and Chelsea Hospitals, 339 Goldhawk Road, London, W 6 (January 6)

DEMONSTRATOR (with honours degree in physics, and capable of carrying out research work in nuclear physics or related subjects, such as electronics) IN EXPERIMENTAL PHYSICS—The Registrar, The University, Liverpool (January 6)

RESEARCH OFFICER (Biophysicist) IN THE DIVISION OF ANIMAL HEALTH AND PRODUCTION, Fleece Analysis Laboratory, Sydney—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting No 3147 (January 13)

CHAIR OF APPLIED MATHEMATICS—The Secretary, Queen's University, Belfast (January 15)

LECTURER IN PHYSICS at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 22)

PROFESSOR OF APPLIED MATHEMATICS at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 31)

READER IN PATHOLOGY at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 31)

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH—The Registrar, Imperial College of Science and Technology, South Kensington, London, S W 7 (February 1)

SENIOR LECTURER IN CHEMICAL PATHOLOGY at the University of Otago Medical School, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (February 1)

LECTURER IN EDUCATIONAL PSYCHOLOGY—The Registrar, University College, Hull (February 10)

JUNIOR LECTURERS IN TROPICAL MEDICINE, PROTOZOOLOGY AND HELMINTHOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1 (February 28)

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S W 1 (April 14)

ASSISTANT FORECASTER (with a university degree, preferably in science and specialized in meteorology, and able to issue weather forecasts independently) by the Government of Iraq for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London S W 1, quoting M 26338 E

CHEMISTS (Experimental Officer grade) in Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 704/50A

CHEMISTS and CHEMICAL ENGINEERS (Scientific Officer grade) in Ministry of Supply Experimental Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting F 726/50A

EDUCATIONAL PSYCHOLOGIST (woman)—The Chairman of Managers, Magdalen Hospital Classifying School Drewstead Road, Streatham, London, S W.16

ENGINEER IN THE DEPARTMENT OF BROADCASTING, Malaya, to instal and manage broadcasting studios, recording channels and transmitters—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27326/39

GRADUATE IN CHEMISTRY, to train for administrative position—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20

HEAD OF THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Principal, West Ham Municipal College, Romford Road, London, E 15

METEOROLOGISTS for the West African Meteorological Service—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting 27118/4

NUTRITION OFFICER (woman) to investigate and advise upon nutrition problems, Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1, quoting No 27321/4

PHYSICIST (about 25) for work on publications—Dr H R Lang, Institute of Physics, 47 Belgrave Square, London, S W 1, endorsed 'Personal'

PHYSICISTS AND MATHEMATICIANS (Experimental Officer grade) in Ministry of Supply Research and Development Establishments mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2, quoting A 330/50A

SCIENTIFIC ASSISTANT—The Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge

TECHNICAL ASSISTANT, male (Assistant Experimental Officer or Assistant (Scientific) grade)—The Secretary, John Innes Horticultural Institution, Bayfordbury, Herts

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Second Cape Catalogue of Stars for the Equinox of 1925 0, consisting of Part 1, Stars south of Dec −30°, Part 2, Zodiacal Stars, compiled from Observations made with the Reversible Transit Circle at the Royal Observatory, Cape of Good Hope, in the Years 1925–1933, under the direction of Dr J Jackson Pp xxiii+168+66 (London H M Stationery Office, 1949 ) 30*s* net [510

Geochimica et Cosmochimica Acta Vol 1, No 1 Pp 72 (London Butterworth-Springer, Ltd , 1950 ) 70*s* per vol [510

Man and his Environment By Prof A Leslie Banks Pp 16 (Cambridge At the University Press, 1950 ) 1*s* 6*d* net [510

Quekett Microscopical Club Monograph No 5 The Binocular Microscope, its Development, Illumination and Manipulation By F C Wise, F E J Ockenden and P K Sartory Pp 30 (London Williams and Norgate, Ltd , 1950 ) 2*s* 6*d* net [510

Tinplate Handbook Facts about Tinplate for Buyers and Users By W E Hoare Pp 31 (Greenford Tin Research Institute, 1950 ) Free [510

National Central Library 34th Annual Report of the Executive Committee for the Year ending 28 February 1950 Pp 30 (London National Central Library, 1950 ) [510

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## Other Countries

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# THE UNITED NATIONS ORGANIZATION

ALTHOUGH the annual reports of the Secretary-General of the United Nations on the work of the Organization have not attracted the attention that corresponding reports on the League of Nations did, and have as yet not gained the reputation enjoyed by those of the Director of the International Labour Organization, they are not unworthy of study Dr Trygve Lie's fifth report[*], covering the work of the Organization during the period July 1, 1949–June 30, 1950, is no exception It has something of the realism which characterized the surveys of John Winant and Harold Butler, and the wide range of activities of the Organization are related to its main purpose in a way which never obscures the fundamental conditions on which the success of the United Nations Organization depends

Dealing first with the detailed activities of the Organization, those of the Atomic Energy Commission perhaps have first claim on the interest of scientific readers Here the Secretary-General's review takes us no further than the Security Council's decisions of September 16, 1949, and the discussions at the fourth session of the General Assembly No more need be said here than that the efforts of the Secretary-General to be impartial never disguise the plain fact that the responsibility for deadlock in this matter rests fairly and squarely on the U S S R and its satellites, through their refusal to consider any effective scheme for international control

In the section of the report which deals with economic and social questions, the economic advancement of under-developed areas, and particularly the question of technical assistance, are of scientific interest Such activities expanded considerably during the year, and under the 1950 programme some sixteen countries have requested expert advice in connexion with their plans for economic development, while the services of about fifty experts, representing twenty different nationalities, have been made available to under-developed countries For example, a group of specialists in agriculture, geology, industry, public administration and other fields began work in Afghanistan in June, and a comprehensive team of experts left for Bolivia in April 1950, to advise the Government on public finance, mining, transport, electric power, labour legislation, social welfare, standards of living, education, agriculture and forestry A soil conservation expert and an expert on community planning and housing have been appointed in connexion with the Government of India's sponsorship of the Palakarni swamp reclamation and development project This project is to serve as a pilot scheme, with broad implications for land reclamation and food production elsewhere in India Arrangements have also been made for the appointment of a resident technical-assistance representative to maintain liaison with the Pakistan authorities and to advise them on the formulation of requests for technical assistance in the light of facilities available through the United Nations The Secretary-General has established the beginnings of a clearing-house service to handle specific inquiries for technical information and for advice on the location of technical personnel, equipment and supplies The United Nations Technical Assistance Conference at Lake Success, held during June 12–14, 1950, marked further the culmination of preparations for launching an expanded programme whereby the United Nations and five of its specialized agencies will co-operate to provide technical assistance for the economic development of under-developed countries on a scale far greater than has previously been possible The agencies in question are the International Labour Organization, the Food and Agriculture Organization, the United Nations Educational, Scientific and Cultural Organization, the International Civil Aviation Organization and the World Health Organization The plan provides for the establishment of a technical assistance board and a technical assistance committee to review developments in this field and co-ordinate action, as well as to review the working relations between the participating organizations with the view of achieving the fullest possible co-operation The basis for the expanded programme is now firmly established, and the programme is ready to be put into operation as soon as the funds pledged at the Technical Assistance Conference become available

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[*] United Nations Annual Report of the Secretary-General on the Work of the Organization, 1 July 1949–30 June 1950 Pp xiv+143 (Lake Success, N Y United Nations, London H M Stationery Office, 1950 ) 11s.

The Secretary-General is also undertaking the organization, within the United Nations, of an international centre for training in public administration The immediate purpose of this institution is to arrange for the training, either abroad or at home, of qualified Civil Servants in specific problems of public administration, so that they may contribute to the improvement of the organization and management of government services in their home countries The long-term objective is to improve and disseminate the art and science of public administration for the benefit of all nations The first seminar was to be held at Lake Success during September 15–November 15, 1950, when thirty participants were expected, selected by the Secretary-General from experts which were to be nominated by the governments of member States

There is a brief reference in the report to the United Nations Scientific Conference on the Conservation and Utilization of Natural Resources, but here, as in all other spheres where the possibility of international co-operation has been so successfully demonstrated, given the will to co-operate and a common purpose, the report reveals how far the world is as yet from any such community of purpose What is said in the report on such questions as the protection of human rights and the promotion of freedom of information makes this abundantly plain, and in his introduction the Secretary-General shows how real progress in all such technical and scientific or social questions is linked up with the political question of world peace The major decisions and acts of the United Nations during the year under review, recorded by him as of potential constructive benefit to th world, all turn for realization on a settlement of th conflicts for power and position resulting from th defeat of Germany and Japan

Dr Trygve Lie points out frankly that the essentia elements of a system of collective security do no yet exist There is no plan for the control, regulatio reduction or prohibition of armaments, includin atomic bombs, nor does any agreement exist regardin the forces that should be pledged by members of th United Nations to enforce decisions of the Securit Council against threats to the peace, breaches of th peace and acts of aggression It is true that, as h notes, the Security Council did act quickly an decisively in Korea, but there is no certainty c probability that it will do so again in the face of th latest and more serious threat, or that it coul marshal quickly the necessary forces While th Secretary-General in his report could take no cogni ance of regional defence developments like thos under the Atlantic Pact or the Council of Europe, i spite of their evident bearing on this matter, the slo progress made in the organization of North Atlant defence or a European army emphasizes the diff culties in collective defence even where no maj ideological differences are involved

Much of this introductory part of the Secretar General's report is concerned with his own efforts an proposals for breaking the deadlock between Eas and West, and for securing a resumption of negotia tions within the United Nations Nevertheless, i seems clear that he himself leans to that view of th United Nations which regards it as an organizatio of like-minded nations co-operating to raise standar of life and achievement throughout the world, rathe than as a body in which nations of very differen outlook may find ways of composing their difference other than by resort to war The latter theory was, o course, one that for long enlisted support for th League of Nations, but experience showed that i spite of the outstanding success of the League i certain technical fields such as health, opium, etc the fact of co-operation in those fields had little effe on the will to co-operate in the political field or th composure of differences there

Even less than when Dr Trygve Lie wrote in Jul last is it possible to be confident about the future o the United Nations and world peace, but the wid spread support among the peoples of the world fo the United Nations and the extent of the constructi work already being carried on under its auspic should nevertheless prevent despair There mus indeed, be a will to peace before peace can be achieve and those who wish for peace must be strong an resolute to pursue it Differences in outlook, in value in philosophy, between East and West need not pr vent a settlement based on mutual respect, but the must at least be a foundation of understanding an of goodwill on both sides Perhaps the most di appointing feature of the whole five years work the United Nations is that repeated manifestatio of goodwill from the West to the East have failed t bring any evidence of reciprocal goodwill from th East to the West

## A PHYSICIST LOOKS AT WORLD AFFAIRS

Out of my Later Years

By Albert Einstein Pp viii+282 (New York Philosophical Library, Inc , 1950 ) 4 75 dollars.

THIS book is a collection of essays, written by Einstein during the period 1934–50, a continuation of the similar work, "The World as I See It", which covers the years 1922–34 Only a small part of the sixty articles deals with science and its philosophy , others give the author's opinion on the relation of science to religion and to life in general, on moral problems, on politics and the social problem, on the Jewish people and their fate

It is impossible to give in a few lines an impression of the fascinating and inspiring ideas, expressed in the simplest possible language, which are contained n these essays A few points may, however, be mentioned The fourth article, of the year 1937, has the title "Moral Decay", and this term appears later again and again, as a kind of *Leitmotiv*, in all articles dealing with the present political situation, the atomic bomb, the treatment of the Jews, etc The eighth ticle, "Science and Religion", contains again a confession which returns in many others that ntelligent thinking plays no part in forming a goal for human endeavour and for ethical convictions—"To make clear these fundamental ends and valuations seems to me precisely the most important function which religion has to perform in the social life of man" What Einstein means by that becomes clear enough from the following considerations the principles of the Jewish–Christian tradition, which he always, also in other articles, regards as a unit But just as strong as his acceptance of these "principles" —obviously the ethical teachings of the prophets and of Christ—is his rejection of the belief in a personal God This opinion is offered in the most simple and humble way as the result of a life's experience and hinking , it is not without connexion with Einstein's deepest scientific convictions

There are two main articles dealing with these, No 13 from 1936, and No 14 from 1940 They eveal much about Einstein's ultimate principles and methods Every physicist will read them with the greatest interest, as they show how it has come about that Einstein has separated himself from the general trend of modern physics The summary of No 13 gives his epistemology in the shortest terms 'Physics constitutes a logical system of thought which is in a state of evolution, and whose basis cannot be obtained through distillation by any nductive method from the experiences lived through, but which can only be attained by free invention" t is just this trust in the power of *a priori* thinking which has led Einstein away from the actual physical esearch into lofty speculations which have so far ttle relation to reality No 14 contains a clear xplanation of the logical situation in quantum theory nd of Einstein's objections to the generally accepted statistical interpretation But this attack is of a milder kind than has ever before come from his pen , leaves "open to every man to choose the direction f his striving", and it ends with "Lessing's fine aying, that the search for truth is more precious han its possession"

The articles grouped under the titles "Public ffairs" and "Science and Life" show Einstein as a olitical, social, ethical humanitarian thinker No 18 is a confession of socialism, but in No 31 there is a warning, directed to the blind believers in the social paradise "Socialism may lead more easily to wars than capitalism because it represents a still greater concentration of power" This problem of war is his main concern, and he sees no other way out but a world government, which he defends and recommends with strong words in many articles, of which No 31 is the most important one To this group belongs also his exchange of open letters with four Russian men of science (No 27) who attack "Dr Einstein's mistaken notions" by a display of the well-known communistic arguments , Einstein's reply is a model of simple reasoning first things first—what advantage do you expect from even the most perfect social system if you perpetuate international anarchy with the inevitable consequence of atomic war and general annihilation ? War and the military mind are Einstein's real enemies which he relentlessly attacks, for example, in No 36 But his disgust about the military expression "human material" and the degradation produced by military discipline does not make him a blind pacifist He appeals to the civilized world to resist aggression, to answer force by force, if necessary, to save its most precious possessions His words about the suffering of the Jews, "his people", are as moving as his pride in the foundation of a Jewish State

Einstein's lovable personality, however, is best revealed in some short biographical essays, beginning with Newton and Kepler and leading to Gandhi and Ossietzky (Nos 38–46) It is not only the achievements of these men which he describes in a masterly way, but also their human greatness The short sketches dedicated to the memory of Marie Curie, Max Planck, Paul Langevin and Paul Ehrenfest are touching documents of Einstein's devotion to his friends

MAX BORN

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## A STUDY OF SOME ODD PERSONALITIES

Very Peculiar People

Portrait Studies in the Queer, the Abnormal and the Uncanny By Dr E J Dingwall. Pp 224+11 plates (London Rider and Co , n d ) 18*s* net

DR E J DINGWALL has two qualities which make his writing eminently readable an intense interest in human beings and a profound and unusual scholarship These qualities are aptly united in this book and its forerunner, "Some Human Oddities", in both of which he makes critical and exploratory studies of strange people and extraordinary happenings In "Very Peculiar People", Dr Dingwall considers Emanuel Swedenborg, Johann Jetzer, a seventeenth-century monk around whom centred amazing events, St Mary Magdalen de' Pazzi, Hadrian Beverland, a Dutch scholar addicted to classical erotica, and Eusapia Palladino, an Italian medium of uncertain authenticity

In three of these brief biographies the main problems are those of psychical research, and the author, without assaying dogmatic judgment, places before the reader the evidence to be considered Unfortunately, as he makes abundantly clear, this is insufficient for more than a verdict of 'not proven' Did Swedenborg in fact possess clairvoyant powers ? We cannot tell, and Dr Dingwall believes that confirmatory facts will never now come to light He suggests, however, that Swedenborg, along with other intelligent and otherwise normal persons whom he cites in the appendix, had built up a vast system of internally consistent hallucinations He believes that this system and its relation to his life as a whole present, quite apart from possible para-normal implications, a valuable field for psychological research

Was Johann Jetzer the victim of practical jokes, or a joker himself, or were his experiences partly genuine ? Here we are in even deeper waters Jetzer appeared to receive the stigmata and divine visitations of various sorts, but afterwards the prior of his monastery and three of the other monks were executed for perpetrating a blasphemous fraud on him Nevertheless, the evidence is so conflicting that one cannot be sure that justice was done, and the whole story makes perplexing and fascinating reading

Was Eusapia Palladino an amazing medium, or an almost equally amazing charlatan ? Here we move into more modern times, and the evidence comes from Myers, the Sidgwicks, Lombroso and Lodge, but even so, we are left with an enigmatic question mark

The other two studies are of a somewhat different character That of Hadrian Beverland shows the gradual decline of a brilliant and sexually perverted scholar He was expelled from the University of Leyden for obscene publications and came to England, where he enjoyed some protection and patronage and lived in some comfort until overtaken by chronic illness and a mental disturbance, the onset of which could no doubt have been predicted from his writings and his mode of life The author suggests that Beverland's decline illustrates the effects of circumstances—he was harshly, if not unjustly, treated in Holland—on the growth of psychological infirmities This may be so, but we do not know enough of Beverland's youth, and when in his early twenties—at which period we pick up his story—he seems already to have been a meaty case for the psychiatrist

In his study of St Mary Magdalen de' Pazzi, Dr Dingwall shows us a determined woman, who from early childhood overrode every obstacle erected by parents and religious superiors, in the effort to lead what she considered the complete religious life Dr Dingwall maintains that her obstinate and inconvenient insistence on her aims, her self-imposed floggings and humiliations, and her frequent ecstasies indicate a highly neurotic character However, it is recognized that a certain measure of neurosis is an inseparable part of psychic structure and that symptoms of unbalance (as we would understand it) cannot be considered as conclusive when taken out of the context of era and society We do not know very much about this Saint, but there are certain other factors which always have to be considered in discussing the lives of the religious The aim of the Christian ascetic is a closer union with God, and the elimination of mental and physical appetites which interpose themselves between the striving soul and its divine goal is a means, but only a means, towards that end From time immemorial physical austerities, often including beating, have played a part in subordinating the inclinations and the will of the individual to the will of God Given this long tradition, and given the purpose behind these practices, are we justified in asserting that, save in so far as the finest motives may be slightly mixed, mental and physical austerities are masochistic ? Whether or not the potential sexual element vitiates the efficacy of flagellation as a means of self-discipline is another The saintly Curé d'Ars, himself once an ardent flagellant, later referred to those activities as his "youthful follies" and said that, so far as austeritie were concerned, the devil was far more frightened b hunger and lack of sleep than by hair shirts or th discipline

In conclusion, the story of St Mary Magdalen de Pazzi reinforces the belief that the word neuroti when used indiscriminatingly to qualify odd c inexplicable behaviour, becomes misleading an meaningless

Dr Dingwall's aim is to "draw the attention c the student to problems so obscure that any rea understanding of them can hardly be said to exist" and he has done so in these stories, and particularl in the erudite appendixes, in so appetizing an stimulating a way that it would be churlish to accor him only amusement value His theme is an old one namely, that human nature is mysterious and tha to jump to conclusions about people is to jump t falsehoods, but it cannot be too often reiterated Dr Dingwall will probably be blamed for not handin out knowledge and synthetic understanding on plate, but by stressing the need for knowledge i fields where tradition or superstition usually giv ready-made answers, he has performed a greate service

ADAM CURLE

## TREATISE OF ZOOLOGY

Traité de Zoologie, anatomie, systématique, bio logie

Publié sous la direction de Prof Pierre-P Grass Tome 15 Oiseaux Pp viii+1,164 (Paris Masso et Cie, 1950) 6,000 francs

ALTHOUGH the present volume is No 15 ou of a contemplated series of seventeen, it actually only the fourth to be published There ha now been time not only to read the three previousl published volumes more carefully but also to us them, and further acquaintance with them has onl served to enhance the high opinion formed upon fir reading Vol 15, which treats of the birds, is full up to the standard of its predecessors and is larg and consequently more expensive than any of then Apart from the introductory portion, the text ru to 1,164 pages It has three coloured plates, of whic the first, illustrating types of eggs, is the best, 51 line diagrams, one in two colours, 121 half-tones photographs, 85 half-tones of drawings, six hal tones of photographs with accompanying explanato line blocks, and twelve maps Since a number these illustrations contain more than one figure, will be seen that the volume is very well illustrate

The contributors are J Bénoit, of Strasbourg, Bourlière, J Berlioz, E Oemichen, J Piveteau ar A Rochon-Duvigneaud, of Paris, E Letard, Alport, M Mayaud, of Samur, J Pasteels, Brussels, A Portman, of Basle, E Matthey, Lausanne, and the general editor of the serie Pierre-P Grassé, of the Sorbonne This list of co laborators not only ensures the authority of the te but also indicates the wide scope of the subjec matter It is this last point that is perhaps the mo striking aspect of the volume as compared with t previous ones, and it is pleasing to see that it reflec the appeal of birds not only to the morphologic zoologist and systematist but also to the ecolog the student of behaviour and the naturalist

In such a wide survey it is only to be expected th the specialist in a particular field would wish to s his own field dealt with in greater detail Thus t cytologist might wish for more than five pages, the student of behaviour might wish for a fuller treatment of the nest building, migration, sense of direction (although this does include a reference to recent work on the possible part played by Corioli's force in this phenomenon), social organization, establishment of territory, etc., and the morphologist for a fuller indication of the great variability exhibited by the main anterior arteries and so on. When one considers how any of these sections could be expanded without enlarging the volume, one is faced with the problem of what could be omitted. Such a consideration brings a realization of the excellent balance between the breadth of outlook and the great amount of detail contained within the book, and in spite of this it is so clear in exposition that it is easy to read.

There are a few slips such as "co do-mésoblaste" instead of cordo-mésoblaste in the legend of Fig. 353 on p. 488. Other mistakes were noted in reading, but it was later found that these and others were corrected in a list of errata on p. 1154. Each chapter is provided with a select and useful bibliography, and the volume has at the end a detailed table of contents and a full index so that reference to any subject is easy. Unfortunately, the publication of the series is falling somewhat behind the announced dates, which is perhaps only to be expected in such a large undertaking at the present time. The editor and publisher alike are to be congratulated on the production of another most worthy addition to the text-books of general zoology.

CHAS H. O'DONOGHUE

# MECHANIZATION OF MATHEMATICS

## Calculating Instruments and Machines

By Prof. Douglas R. Hartree. Pp. ix+138. (Urbana, Ill.: University of Illinois Press; London: Cambridge University Press, 1949.) 21s.

THE almost exponential rise in the output of scientific and technical research which has been such a marked feature of the past few decades has presented many mathematical problems the solution of which is not possible by known formal methods. The result has been on one hand the development of approximate methods of solution, of which Southwell's 'relaxation' method is an outstanding example, and on the other hand the development of instruments and machines which can carry out speedily and mechanically the complicated mathematical operations involved. The present book, by one who has played a leading part in the utilization of instruments and machines, and in encouraging their development, provides a very welcome addition to the literature of the subject. It is well produced, well illustrated by photographs and diagrams, and contains at the end a list of 122 references.

The book is based on a course of lectures given by the author, so that he has concentrated on those aspects of the subject which interest him most, and on those instruments and machines with which he is most familiar. This has led to the exclusion of reference to devices limited to the solution of a particular problem or equation, and attention is devoted entirely to 'physiology'—what a machine can do and how it can be made to do it—and not to 'anatomy', although occasional reference is made to components ('hardware') out of which machines are constructed. It is to the user, rather than the designer, that this book will mainly appeal.

The distinction which the author makes between instruments and machines is that which the Americans denote by the adjectives 'analog' and 'digital'. In the former, numbers are represented by some physical quantity; elementary examples are graph paper and the slide rule; but the section of the book devoted to instruments deals almost exclusively with the differential analyser. Machines deal directly with numbers: the human hand and the abacus are primitive forms, but the author is here concerned with the various automatic high-speed digital machines in use or under construction in Great Britain or in the United States. For each class fundamental principles have long been known. Kelvin realized how coupled mechanical integrators could solve differential equations, while Babbage's 'analytical engine' was designed to perform the same kinds of operation as the modern machines. It is to advances in mechanical and electrical engineering, and to increased demand, that modern progress is mainly to be attributed.

Mechanization is no substitute for intelligence. As Lady Lovelace remarked in her account of Babbage's plans, these machines can do only what we know how to order them to do. Moreover, they each have their own idiosyncrasies, their special aptitudes, and their limitations. To take full advantage of the special aptitudes, and to avoid the limitations, may call for considerable ingenuity. The new machines demand a new mathematics—or at least a new approach to mathematical problems—in a word, the cultivation of a 'machine's-eye-view'. This means an analysis of the calculation into a sequence of steps within the capabilities of the machine, or, in some cases, even an alternative formulation of the problem, which allows such an analysis more readily to be made. Instances of this are scattered throughout the text, in connexion with instruments and machines as each is considered, and in the highly suggestive final chapter. The machine's-eye view also means the ability to foresee all the snags.

Although the chapters on the differential analyser show that there have been recent advances both in its design and use, interest to-day is centred rather in the development and use of high-speed automatic digital machines. In the earlier machines of this type emphasis was laid on the reduction of computational labour, and elaborate arithmetical units were built in, such as multiplier-dividers and square-rooters. Experience in use showed a need for much more high-speed storage of both numbers and instructions ('memory'). To-day the tendency seems rather in the direction of quite simple arithmetical units, fundamentally addition units, frequently working in the binary scale, combined with greatly increased storage and control facilities. Multiplication is repeated addition, and the author shows how division can be done by an iterative process involving only addition and multiplication, and that much more complicated calculations can be similarly performed. This lays the emphasis on programming and coding, which take times enormously long compared with those required for the most complicated sequences of arithmetical operations. But programming and coding still seem to need the human brain, training, knowledge, and experience. To keep one of the new machines running at capacity would seem to demand a skilled staff by no means small.

W. G. BICKLEY

### Principles and Practice in Organic Chemistry

By Prof J. Lucas and David Pressman Pp xi+557 (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 48*s* net

THERE is always some danger that the student who studies the fundamental principles of chemistry under the heading of physical chemistry may overlook the application of these principles to the operations of the organic chemical laboratory This volume, which is intended as a class-book for a one-year course of practical organic chemistry, has been designed to guard against such a tendency by directing attention to the physico-chemical aspects of the reactions used in preparative work In addition, therefore, to the usual preliminary description of general laboratory methods, a first chapter is devoted to such topics as the factors influencing reaction velocity, chemical equilibrium, heats of reaction and of formation, changes in free energy and their calculation from available data Tables of bond energies, resonance energies and free energies are provided

In subsequent chapters which include detailed instructions for preparing more than eighty representative organic compounds, thermochemical and kinetic considerations are discussed at appropriate points Quantities are stated in moles in order to emphasize molecular proportions and also to facilitate the use of alternative substances in the preparations. Notes and questions, calculated to stimulate thought, are added after each experiment

The selection of experiments is good The preparations include a wide range of aliphatic and aromatic substances, a few amino-acids, sugars and heterocyclic compounds, and one chromatographic separation Typical qualitative reactions of each class of substance are given, and a final chapter provides a brief general scheme of qualitative analysis This is an excellent book which should help to make the organic laboratory a place of sound general chemical education G M B

### A Review of Recent Advances in X-Ray Analysis, by Sir W. Lawrence Bragg ; and The Impact of Radioactivity on Inorganic Chemistry, by Prof H. J Emeléus

(Post-Graduate Lectures given to the Oil and Colour Chemists' Association ) Pp 99+10 plates (Cambridge W Heffer and Sons, Ltd , 1950 ) 12*s* 6*d* net

THIS short volume contains the substance of two groups of three lectures, each on the subjects indicated in the title and delivered before the Oil and Colour Chemists' Association in 1947 and 1948 The choice of subjects for these lectures is particularly appropriate since both X-ray analysis and radioactivity have a widespread and growing interest in many branches of science Moreover, the authors are not only acknowledged experts in their respective fields, but also have the happy knack of presenting scientific information in a lucid and interesting way

In the first three lectures, Sir Lawrence Bragg describes X-ray analysis by analogy with the optical diffraction grating, with illustrations derived from the structures of many inorganic compounds , he then discusses the variations from the perfect lattice, the structure of some elements and metal alloys, and concludes with a description of work on X-ray analysis of organic compounds The difficulty and labour of interpreting the results in X-ray work is very well brought out in these lectures Prof H J Emeléus develops his theme of radioactivity against a historical background and follows this account, which includes atomic fission and the chemistry of the transuranic elements, with a discussion of the measurements, handling and production of radioactive substances The final lecture describes some of the manifold applications of radioactive tracers in chemistry and biology

The scope of the subject-matter is necessarily limited in a book of this size, but there is much stimulating information which should appeal to a very wide circle of readers wishing to know more about developments in these two very important subjects It is pleasant to see a book which is not only very moderate in price according to present-day standards, but is also well bound, printed and illustrated F H BURSTALL

### Trilinear Chart of Nuclear Species

By William H Sullivan Pp 4+chart (in 6 strips) 10½ in × 194 in (New York John Wiley and Sons, Inc , London Chapman and Hall, Ltd , 1949 ) 20*s* net

THE trilinear chart has been developed from the more familiar charts of nuclear properties in which $(A-Z)$ or $A$ is plotted against $Z$ (where $A$ and $Z$ are the atomic mass and atomic number respectively) It allows the simultaneous plot of $A$ against $Z$, $(A-Z)$ against $Z$ and $(A-Z)$ against $A$, so that isotopes, isobars, isotones (nuclides with the same number of neutrons) and isodiapheres (nuclides with the same excess of neutrons) lie on straight lines. All known nuclides are represented by hexagonal panels, those which occur naturally being distinguished from those produced artificially by different background colours Nuclear physical constants (natural isotope abundance, angular momentum, slow neutron cross-section, half-life, etc ) are shown in the panel of each nuclide However, such an extensive list of symbols (fourteen in all) requires some reference to the key, and it would perhaps have been advisable to tabulate some of the data (for example, fission yields) The printing on the green field (naturally occurring nuclides) is clear, but a bolder type could have been used to advantage on the lavender background (artificially produced nuclides)

G B COOK

### Modern Synthetic Rubbers

By Dr Harry Barron Third edition, revised and enlarged Pp xix+636 (London Chapman and Hall, Ltd , 1949 ) 45*s* net

THE third edition of "Modern Synthetic Rubbers" is excellently produced and well illustrated, and contains much new information which has been obtained from B I O S and C I O S reports There is also a new section on compounding

The author sets out to cover in the very short space of six hundred pages the field of synthetic rubber production and technology from preparation of the monomers to processing of the elastomers The result is that emphasis is almost entirely on the practica aspects of synthetic rubber production, and at times this leads to a catalogue-like style of presentation However, the merits of the book more than compensate for the mental indigestion occasionally induced Mistakes are few, but the reviewer was surprised t find the statement that rubber has a "trans" structur and gutta-percha a "cis" configuration appearing i the third edition of this work

The book should prove of interest to all who ar interested in the study of high polymers

# CHEMISTRY AND BACTERIA*

By SIR CYRIL HINSHELWOOD, F.R.S

IN a culture tube where bacteria grow, some very amazing chemical syntheses go on, with very simple starting materials, and at a great rate. The medium need contain no more than, say, glycerol, ammonium sulphate, phosphate and a few inorganic ions such as potassium and magnesium, and in a few hours a number of cells, which at the start may equal in number the population of the city of Westminster, will have increased so as to exceed the entire population of the continent of Asia. Nor do the cells which perform these feats possess anything in the way of specialized organs. Their internal constitution is not absolutely homogeneous, as special staining methods and observation by the phase-contrast microscope show; but the internal differences are extremely fine-grained, and are, as it were, of a colloid chemical, rather than of a mechanical or physiological degree of differentiation.

Unlike many other organisms, moreover, bacteria, according to the precise conditions of their growth, may vary enormously in size and shape, from nearly spherical cells to long filaments the length of which exceeds their breadth by hundreds of times. The addition to the medium of specific drugs which act separately on growth and division, or even the control of the osmotic conditions, causes these changes, and impresses on us that the cell is, in a sense, an elaborate piece of chemistry rather than a set of organs. The question, then, is how this chemistry is organized. My general thesis is that many characteristic properties of the cell—and these include phenomena which are very typical of the living process in general—are determined by the particular *pattern* of the chemical reactions which take place there. We must examine the nature of this pattern.

In the first place, there is an intimate *linking* of various reactions. The living cell is continually creating order, without, of course, violating the Second Law of Thermodynamics. This being so, reactions involving a decrease of free energy are intimately linked with others which involve an increase. The coupling is possible in virtue of the general tendency of chemical reactions to occur in a series of stages. When we say that the reaction $XY = X + Y$ is coupled with the reaction $B + A_2 = BA_2$, it is not a question of some resonance like that of radio circuits, but of an interlocking of reaction steps such as the following

$$\begin{aligned} A_2 &= A + A \\ A + B &= AB \\ AB + A_2 &= BA_2 + A, \end{aligned}$$

with the additional stages

$$\begin{aligned} A + XY &= AX + Y \\ AX + B &= AB + X \end{aligned}$$

If this linking of reactions is necessary for the whole energetics of the cell—in order that, for example, the oxidation of glucose should pay for the synthesis of an unstable protein—it is not surprising that it is responsible for a good many special effects as well.

It seems likely that there is in the cell a sort of elaborate production line, in which the products of one enzyme reaction are passed on and constitute the raw material for the next. The unit processes in this series are probably fairly simple. This is a fair inference from the fact that the cell can utilize an enormous variety of substances with its normal apparatus, a versatility which is most easily understood if the unit operations are relatively simple ones, and if the great variety and complexity of the reactions depend upon the pattern of unit processes which is employed to any given end.

Certainly the idea of the long series of consecutive reactions is consistent with the law of growth. Ordinarily, there is, when a number of cells is transferred to a new medium, a considerable *lag* phase, the lag representing the time necessary for the establishment of the stationary state in the sequence of reactions, that is, for the building up of the requisite concentrations of the various intermediates. When this steady state is reached, we have the condition of logarithmic growth. In this phase the amount of bacterial substance increases with time according to the well-known exponential law

$$\frac{1}{x}\left(\frac{dx}{dt}\right) = \text{constant}$$

Every single constituent of the cell now reproduces itself identically by the end of a period called the mean generation time.

The implications of this law are important. A living cell consists of an elaborate macromolecular pattern of proteins, polysaccharides and other substances, including those which seem to play a special part in determining its architecture, namely, the nucleic acids. Parts of the protein structure constitute the enzymes, which can often be separated from the cell and made to catalyse a wide variety of reactions in test-tubes. These enzyme reactions occur without the growth of the cell, but the growth of the cell does not occur without the enzyme reactions. In the process of logarithmic growth, every part of the cell substance is reproduced, and it seems almost certain (it is at any rate a hypothesis that we shall make) that the catalytic functioning of the enzyme substance and its reproduction are intimately linked.

This may happen in the following way: suppose we have two enzymes, each using as substrate for self-synthesis something supplied by the other. We can write down the differential equations for the reaction velocities, and we can show that each of the two enzymes will multiply in amount according to the autocatalytic law of logarithmic growth. Thus, although we have, in fact, a system which depends for its functioning upon the linking of two processes, the reproduction of each enzyme is effectively autosynthetic, and we may write as an overall result for each enzyme:

enzyme material + diffusible intermediate
metabolite =
increased enzyme material + products utilizable
in further stages of synthesis

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* Substance of a Friday Evening Discourse at the Royal Institution, delivered on November 3.

'Diffusible intermediate metabolite' is written because in general the substrate on which the enzyme acts is not the gross raw material of the medium, but something supplied by another enzyme

It must be admitted that a system of two enzymes linked in the way I have described is a very drastic over-simplification, yet it does not seem too much to generalize and to suppose that the equation written above applies in general to the growth and expansion of each of the enzymes associated with the various stages in the long and complex synthetic production line One author has commented adversely on this scheme as an explanation of autosynthesis He would have been quite right if it had ever been intended as such, but it is not It is a statement about the dynamical pattern of cell reactions and its interest lies not in itself, but in its consequences

We have a series of consecutive reactions, by which a series of enzymatic structures is reproduced The whole system, in the steady state of growth, comes into a balanced state where formation and consumption of all intermediates are equal The differential equations for the rates of autosynthesis of the different parts of the cell can now be written down From them there follows the result that, with a constant set of reaction-velocity constants, the proportions of the different kinds of enzyme material in the cell will settle down to steady ratios If, however, the conditions are changed so that the relative velocity constants are altered, then the proportions gradually shift during growth until a new steady ratio is attained

One point may be referred to here in connexion with the linking of use and synthesis in enzyme material We find that when cells are exposed to ultra-violet light and nearly all are killed, the few survivors contain mutants which are very deficient in growth power in the normal simple synthetic media When, however, they are left to grow in a struggling fashion for some time, complete recovery eventually takes place

The change in proportions of the various kinds of enzyme material would appear to be very significant in connexion with the striking phenomena of adaptation Some cells when transferred, for example, from a familiar source of carbon like glucose to an unfamiliar one like D-arabinose, exhibit at first extreme reluctance to use it, after a period of delay and slow growth, they finally learn, as it were, to utilize it with a maximum efficiency. Again, many cells are inhibited by drugs such as sulphonamides, but after growing rather lamely for a time in presence of amounts of the inhibitor just insufficient to stop growth altogether, acquire what is called 'drug resistance' and then multiply quite happily By successive increases in the 'training concentration' they may be rendered resistant to amounts a hundredfold that which would originally have stopped all growth

There is a relatively simple chemical explanation of drug adaptation Suppose the drug inhibits the action of a particular set of enzymes At first the synthesis of certain parts of the cell is retarded Now the cell may very well refuse to divide until certain essential parts have attained some critical magnitude Multiplication will therefore be held up By the time it does occur, other parts of the cell, which were not inhibited, have attained more than the usual proportion These enzymes yield an excess of the intermediates used by those enzymes which the drug blocks This enhanced concentration can now antagonize the inhibition by the antibacterial drug

The differential equations of a simple model of such a system show that the enzyme proportions will change until the growth-rate of the cell as a whole returns to its usual value in the absence of the inhibitor Here, then, we have a mechanism which gives an automatic development of a drug resistance

Whether, in fact, it operates in real cells, or whether drug resistance is due to chance mutation and selection, is a large question about which I will deal later For the moment, however, I want to explain chemical hypotheses rather than to defend them, and I will only remark that if such a mechanism plays no part in Nature, we need an explanation why not

Next we should consider adaptation to new sources of material, such as when the bacteria learn to use nitrogen from ammonium salts instead of an amino-acid mixture, or acetic acid instead of a sugar As I remarked before, the total sequence of reactions in the synthetic chain is probably divided into relatively simple unit processes, and it is the order and combination of these, and the relative amount of functioning required from each of the relevant enzymes, which varies as we pass from one source of raw material to another

Various routes are possible from a given raw material to the finished cell material Examination of the differential equations of a simple model with competing reaction sequences suggests very strongly that, during continued growth, there will, in fact, be established that one which gives the optimum overall rate The proportion of the various enzymes will settle down to the value which ensures this Here again it is the dynamical pattern—linking of functioning and synthesis, and the existence of the production line of consecutive reactions—which leads to the automatic adjustment of growth-rate to that which leads to optimum efficiency

Now adaptive processes are very characteristic of living material We see that two major types of adaptation are referable to the nature of this dynamic pattern of reactions They depend upon propositions about consecutive reactions

Before we turn to the question of alternative biological hypotheses, we will examine one or two other types of reaction pattern, and see what may be derived from them

One way in which a series of chemical reactions can be linked is cyclically A given enzyme of a sequence may produce a diffusible intermediate which is one of the necessary reactants or catalysts for one of the earlier enzymes of the same sequence In this way a cyclical system is set up The differential equations of a simple system with this mode of linking show that if the initial concentrations of certain intermediates happened to be zero, the cycle could not begin It would have to wait until primed with a minute trace of one of the substances which could set the cycle in operation Now when cells which have finished growing are left in the resting state, intermediates are lost by diffusion (and no doubt as the result of other reactions), and if we have any cyclical linking, the result of these losses may be so serious that the steady state corresponding to logarithmic growth will take a very long time to re-establish itself This may well be the explanation of the very long lag phase which sometimes develops in resting cells It is, indeed, fair to say that the lag phase develops more rapidly than might have been expected from the observed rate of decay of individual single enzyme activities.

In a complex pattern of chemical reactions a considerable part might be expected to be played by parallel or competing processes. The existence of these can account for certain remarkable properties of the cell. Just as the pattern of consecutive reactions had a lot to say about the adaptive capacities of the cell, so the pattern of competing reactions explains various phenomena in which, to the casual observation of the natural historian, the cell might be supposed to exhibit choice or purpose. I shall deal with one example, namely, the Pasteur effect, and even this I shall consider mainly in the light of experiments which Dr. A. C. Baskett has recently made in Oxford on the oxidation-reduction properties of *Bact. lactis aerogenes*.

Suppose the cells grow with glucose as the carbon source and with a plentiful supply of molecular oxygen. The glucose is broken down, at least partly by way of pyruvic acid, and much is finally oxidized completely. There is a long series of oxidative steps, and various intermediates are tapped off, aminated and converted into cell material. In the oxidative steps various carriers receive the hydrogen, and they are re-oxidized by a system which ultimately uses molecular oxygen. In the steady state, the re-oxidation of the hydrogen carriers must, of course, balance their reduction.

Now suppose the system is made anaerobic. The aerobic mechanism is replaced by fermentation of glucose; the growth-rate is slower; and the rate of consumption of glucose is much higher than before. In other words, much is wasted. Now suppose that oxygen is passed into the anaerobic culture. The fermentation reactions are now largely inhibited, and although the growth-rate increases, the consumption of glucose actually drops. It seems as though, when the economical aerobic process is available, the wasteful fermentation process is largely inhibited—as though the cell could select which of two kinds of reaction would serve its purpose more efficiently.

What seems to happen is this. The glucose is oxidized in a series of stages, hydrogen carriers being reduced. These must be re-oxidized. If the enzyme system ultimately dependent upon molecular oxygen can operate, it keeps the carrier system $X$, $XH_2$ in a highly oxidized form. If there is no oxygen, $XH_2$ (and in turn other reduced substances $YH_2$ and so on) build up: there is an autosynthetic expansion of an enzyme system which enables these to be re-oxidized at the expense, not of molecular oxygen, but of wastefully reduced carbon compounds (derived ultimately from the glucose or other primary substrate). Hence the wasteful consumption in the anaerobic process. As soon as air is supplied, the system $X$, $XH_2$ (and others in equilibrium with it) now enters in competitive reactions (*a*) with oxygen and (*b*) with the compounds which would re-oxidize $XH_2$ in absence of oxygen. The presence of oxygen must lower the concentration of $XH_2$ and therefore, besides providing the aerobic mechanism, actively cuts out a part of the alternative mechanism which is essential to the fermentation: hence the inhibition of the latter, and the saving of substrate.

Similar explanations based upon the pattern of competing and parallel reactions explain facts such as the inhibition of nitrate reduction by cells which are provided with ammonium salts as a source of nitrogen, and the inhibition of nitrate reduction of certain cultures when they are first made aerobic.

In all the above examples, I have wished simply to point out that certain very characteristic biological phenomena could depend upon patterns of chemical reactions, and have what we may call a kinetic explanation.

That things do so happen is not infrequently called in question by biologists. Here some extremely interesting questions arise which are worth a brief discussion on their own merit.

Let us consider the problem of adaptive changes. We may start with the specific example of drug resistance. According to some biologists, this can concern the chemist only in a very indirect way. Drug-resistant cells are supposed to arise not by any interaction of cells and their environment, but by chance mutations, the only effect of the medium being to select those individuals which, in fact, happen to be able to grow in it, and so to eliminate the normal non-resistant cells. The chief reason for this view was originally the belief in the non-inheritance of acquired characters. Once trained to resist, say, a sulphonamide drug, bacteria pass on the capacity to their progeny for many generations. Now it is, of course, well known that characteristics which animals and plants have acquired by nurture, exercise or mutilation are not passed on to their descendants (at least in the vast majority of cases). To suppose that an acquired drug resistance could be heritable was deemed Lamarckian and therefore heretical. Hence, it was argued, the apparently adaptive modifications must be the result of chance modifications in genic material not directly affected by the environment.

This is not really a logical view at all. Unicellular organisms are different from complex animals or plants in some important ways. They are directly exposed to the action of the environment, and all their chemical reactions are subject to the direct intervention of any substances that the medium may contain. Complex organisms, on the other hand, have their reproductive processes localized in special cells, so that chemical influences of the medium probably never reach them. Modifications of animals and plants are far more likely to be due to Mendelian recombinations of relatively unchanging genes than to chemical changes in the cell material as a whole. This does not mean to say that such changes may not play very important parts in the behaviour of bacteria.

There is really no antagonism here: it is simply a question of the relative importance of two kinds of process (both of which might be expected to occur in one or another kind of example). The chemist, therefore, is not, I think, being heretical if he makes hypotheses about adaptive changes in unicellular organisms. It is a matter for detailed experiment to find out what does, in fact, happen. Here a great many subtle considerations arise.

It will be useful to examine some arguments on the two sides: whether, namely, adaptive changes in bacteria are provoked chemically in some such way as I have discussed earlier, or whether they depend upon chance mutations.

One of the arguments now much in vogue is a statistical one originated by Luria and Delbrück, and which is briefly as follows. A large number of different cultures of an organism are plated out in presence of an antibiotic such as penicillin. The number of resistant colonies which grow shows very wide variations. On the other hand, a corresponding number taken from a given culture does not show this wide spread. It is argued that this must be explained by random mutations If a mutation occurred late in a given culture, there would be few mutants in a sample tested by plating if it had occurred early, there would be many This argument is open to a grave objection A recent paper by Eriksen has shown that the spread of the results is a peculiar function of the exact conditions of the test Ten samples of different cultures cannot be statistically comparable with ten from the same culture, because the ages of the ten different cultures cannot possibly (owing to fluctuations in growing times) be as closely controlled as those of ten parallel samples taken from a given culture In any event, a variability in the initial power to survive penicillin treatment would not preclude an adaptive development of this resistance

Time does not permit a detailed discussion of this interesting topic, but I have perhaps said enough to indicate what an interesting statistical problem is presented

Another line of argument is the following When certain bacteria are inoculated into a new medium (say D-arabinose instead of glucose), there may be a lag of several days before they grow According to one view, this lag represents the time required for the setting up of the new steady state in the reaction sequence, according to the other, it represents the time required for the multiplication of the minute proportion, say $1/10^6$, of the mutants already there Now suppose we transfer $10^4$ cells If there were only the small proportion of mutants supposed, then there would be only a 1/100 chance that the inoculum contained a mutant. According to the adaptation theory all might grow Tests with transfers of different sizes show that, in fact, in some examples practically all the transferred cells do, in fact, grow given the requisite time This is a *prima facie* case for the theory of direct adaptation

There is an objection, however, which is difficult to counter directly The new medium may contain enough impurity to support a minute growth of non-mutant cells Although this growth may be below the threshold of visibility, it may be enough to allow the throwing off of some extra mutants to account for the final positive result This explanation will only work if some rather *ad hoc* assumptions are made about the impurities which various media do or do not contain, and without much direct evidence we may say, therefore, that the objection is in a sense an unfair one, though none the less difficult to refute We must turn, therefore, to other lines of evidence

Interesting considerations arise in connexion with the stability of adapted forms I will quote a specific example *Bact lactis aerogenes* shows an initial lag of 30–40 hr when it is first cultured in the sugar D-arabinose If this lag were, in fact, the time required for the multiplication of the mutants already there, it would be necessary to assume about one mutant in about ten million cells This fraction does not increase with the history of the strain, so we must suppose that the very small proportion is due to an equilibrium between mutations and reverse mutations Since the equilibrium proportion is very small, the reverse mutation-rate has to be assumed very large On this basis one can calculate how fast the cells should lose the acquired power of utilizing D-arabinose the answer is that they should revert at a considerable rate In fact, the adaptation is very stable

To retain the mutation hypothesis, special assumptions have to be introduced, and these are not of a very probable kind Moreover, the ease of reversion of adapted cells is, in general, a very marked and regular function of the thoroughness with which they have been originally trained. To save the mutation theory here we have to postulate successive mutations, the first to give a new property and the second to render that property stable On the other hand, various simple chemical hypotheses about stability of adaptation can be made, and, while it would not be fair to say that they encounter no difficulties, I think the difficulties may be said to be much less serious

Another line of evidence which I find interesting is the fact that the various kinds of adaptation are additive By suitable procedures one can train *Bact lactis aerogenes* to utilize lactose with optimal efficiency the resulting strain is called *L* Similar strains can be trained to use sucrose (strain *S*) or maltose (strain *M*) with maximum efficiency By suitable procedures one can prepare strains which utilize pairs, or all three with optimal efficiency *LS*, *LM*, *MS* and *LMS* If all the capacities are acquired by chance mutations, as they might *possibly* be, one can only say that the role assigned to chance is a rather remarkable one

There is also a quantitative side to the matter If we train bacteria to resist a drug such as proflavine (diamino acridine), the resistance will be exactly graded to the concentration at which the training was carried out A complete set of strains can be prepared with resistances exactly related to the concentration of the drug in which they were adapted According to the kinetic picture which I mentioned earlier this is very natural, but according to the mutation theory it implies a whole series of mutations of a numerous and complex character

To sum up the situation, I would say that in respect of these particular phenomena the chemical theories have the advantage, not perhaps in the absolute, but at least in the light of the famous scholastic principle *Entia non sunt praeter necessitatem multiplicanda*

No reasonable man of science could possibly deny that genic re-combination phenomena play an enormously important part in biology, but that alongside these, effects depending ultimately upon the dynamical pattern of the cell reactions also play their part, is a hypothesis which I think the chemist may find fruitful for some time yet

# SEPARATION AND PURIFICATION OF ENZYMES ASSOCIATED WITH INSOLUBLE PARTICLES

By R. K. MORTON*

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RECENT studies on the distribution of intracellular enzymes have clearly demonstrated that many are closely associated with well-defined cell components[1,2] Autolysis and digestion with lipases, trypsin and papain have been used for bringing into solution several enzymes associated with these insoluble particles, while sonic vibration[3,4] and treatment with sodium deoxycholate[5] have enabled some separation of components of mitochondria. These methods have limited application, and all are more or less undesirable for enzyme purification. Some enzymes are altered or destroyed by proteolytic procedures, while contaminating products are formed during digestion; sonic vibration may only cause increasing dispersion of cell material, and there is considerable possibility of denaturation; and sodium deoxycholate may promote 'solution' through micelle formation, as is the case for most detergents.

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The application of alcohols (propyl and shorter chain-length) to the separation of the water-soluble enzymes of muscle has recently been investigated[6]. The controlled use of *n*-butyl alcohol has now been found to enable ready solution of a wide range of enzymes from insoluble particles into distilled water or dilute buffers, apparently by removal of lipid and other material from cell structures. The method appears capable of considerable extension and development, not only for the separation and purification of enzymes from animal and plant tissues, yeasts and bacteria, but also for the isolation of other biological materials.

## Specific Action of *n*-Butyl Alcohol

Investigation of several alkaline phosphatases of animal materials suggested that true solution of the enzymes was prevented by association of the protein with lipid material. Of a wide range of organic solvents tested with varying procedures, *n*-butyl alcohol alone appeared capable of removing the lipid sufficiently to enable quantitative solution of the active enzymes in the aqueous phase.

This alcohol is ideally suited to enzyme purification. Low solubility permits saturation of the aqueous material without loss of activity (in the case of enzymes so far investigated); lipids, organic esters and other materials soluble in the excess alcohol are removed from the aqueous phase; protein denaturation can be controlled by use of proper extraction conditions; and enzymes are frequently recovered almost quantitatively in clear water solution. The alcohol in the aqueous phase may be removed by dialysis, or the enzymes precipitated directly with other organic solvents. Further purification of the enzymes is then possible using normal procedures.

Where an enzyme is unstable to treatment of wet material with the alcohol, it may be useful to remove lipids by extraction of the acetone-powder or vacuum-dried preparation with dry *n*-butyl alcohol at low temperature. Following appropriate removal of the alcohol, the protein may be brought into solution in distilled water or buffer. Freezing the material with *n*-butyl alcohol at very low temperatures, such as those used with ether treatment of plasma proteins[7], has not been found of any advantage with enzymes so far studied.

## Method for Enzyme Purification

The procedure adopted for the purification of alkaline phosphatases is given in detail since it illustrates the general method. Appropriate modifications have been introduced for the extraction and purification of other enzymes.

### Phosphatases

*Alkaline Phosphomonoesterase.* This enzyme is closely associated with the cell nucleus in animal tissues[1,2] and in milk with insoluble lipid material[8,9]. Prolonged autolysis and tryptic digestion have both been used previously as essential preliminary procedures in purification, although some of the enzyme may be obtained in solution by other methods[10].

*Intestinal Phosphatase.* Approximately 3 litres of calf intestinal mucosa is dispersed with vigorous mechanical stirring in distilled water to a total volume of 10 litres. Acetate buffer (2*N*, *p*H 4·5) is added and the precipitate at *p*H 5·1 separated in a 13-litre serum centrifuge (2,000 r.p.m., 20 min.). This precipitate, consisting largely of cell fragments, is washed with 8 litres of distilled water and again dispersed in distilled water to give a suspension of 5 litres, *p*H 5·2–5·5.

Slow addition of 2 litres *n*-butyl alcohol (laboratory reagent grade) with vigorous mechanical stirring at room temperature forms an emulsion and precipitates a considerable portion of inactive protein. The emulsion is rapidly stirred and heated to 32° C. for 5 min. by immersion of the stainless-steel container in a water-bath held at 40° C. When centrifuged (2,000 r.p.m., 20 min., in 1-litre glass cups) the material separates into distinct layers comprising a heavy precipitate, a clear yellow aqueous zone overlaid by light particles, and a surface layer of excess *n*-butyl alcohol containing dissolved material. The latter is readily removed by suction and the butyl alcohol recovered by distillation. The aqueous phase is conveniently removed by suction through a narrow glass tube and filtered if necessary.

The solution contains about 50 per cent of the original phosphatase of the mucosa, and has a $Q_p$ of about $10^4$. Further purification by usual methods has yielded final preparations with a $Q_p$ of between $5 \times 10^5$ and $10^6$, and these are thus about five times more active than any previously reported[11]. Recovery is between 20 and 30 per cent. It is noteworthy that the enzyme may be quantitatively eluted from a variety of adsorbents at any stage after true solution is obtained by the treatment with *n*-butyl alcohol (compare ref. 12).

*Other Phosphatases.* Serum ('buttermilk') obtained from cream of 60–70 per cent butterfat is treated with excess *n*-butyl alcohol at *p*H 5·2 and heated to 35° C. for 5 min. to give a clear yellow phase containing the alkaline phosphatase of milk in true solution, free of casein.

Further fractionation and adsorption procedures have given a preparation with a $Q_p$ of $10^5$. This represents a purification of approximately 5,000 times as compared with normal milk, and the preparation is about a hundred times more active than any previously described[9,13]. Appropriate modifications of the above procedures have been used for the separation of phosphatases from mammary gland, kidney, liver and yeast, substantiating the general applicability of the technique.

*Pyrophosphatase.* The enzyme of optimum *p*H 7·6 (for hydrolysis), closely associated with alkaline phosphomonoesterase in animal tissues[14], is readily brought into aqueous solution from intestinal mucosa and kidney by the use of *n*-butyl alcohol.

*Adenosine Triphosphatase.* It appeared possible that enzymes specifically catalysing the breakdown of adenosine triphosphate might be closely associated with lipids, as are animal monophosphoesterases. A magnesium-activated adenosine triphosphatase of muscle has been reported to consist of such an association of protein and phospholipid in a complex the integrity of which is essential to enzymic activity[15] An adenosine triphosphatase has also been reported to occur in isolated mitochondria[16]

Treatment of rabbit muscle and liver preparations with *n*-butyl alcohol permits isolation of the adenosine triphosphatase activity in the aqueous phase Apparent separation of the calcium-activated enzyme from rabbit-muscle myosin into a clear salt-free solution has now been achieved by extension of the same method It may be that this enzyme is also associated with phospholipid or similar material, which is always co-precipitated when myosin is prepared by the usual methods It is noteworthy that the myosin remaining after *n*-butyl alcohol treatment appears undenatured as judged by the ready solubility in 0 5 $M$ potassium chloride ($p$H 7 2)

### Peptidases

*γ-Glutamyl Transpeptidase* An interaction between glutathione and free amino-acids with formation of γ-glutamyl peptides ('transpeptidation') has recently been described[17] The enzyme catalysing this reaction is probably identical with one in pig kidney described as associated with a "lipoprotein of high molecular weight"[18] By *n*-butyl alcohol treatment it has now been obtained in clear solution from both sheep and ox kidney

The homogenates at $p$H 6 8 are treated with excess *n*-butyl alcohol, centrifuged, and the clear aqueous layer containing the enzyme dialysed against 0 05 $M$ phosphate buffer, $p$H 7 4 These procedures are carried out at low temperature (0°–2° C )

By subsequent fractionation, water-clear active preparations of low protein content have been obtained Similar treatment of minced mammary gland from a lactating cow has also given clear preparations found to contain an enzyme with 'transpeptidase' activity

*Cysteinyl-glycine Dipeptidase* A recent paper has reported the separation of this enzyme from its physical association with the transpeptidase enzyme of pig kidney[19] It is noteworthy that shaking with chloroform is an essential part of the purification method therein described By treatment of ox kidney with *n*-butyl alcohol, this enzyme may also be readily brought into clear solution and purified by subsequent fractionation procedures

### Dehydrogenases

*Succinic Dehydrogenase* This important enzyme is readily obtained in mitochondrial preparations and has been intensively studied in such colloidal suspensions A brief account of the extraction of a small amount of the enzyme from liver mitochondria of guinea pig has been published[20], but no further details of this work have appeared Attempts to repeat the extraction procedure with calf-liver and horse-heart preparations were unsuccessful in this laboratory A recent paper[3] has described further investigations designed to obtain this and other enzymes in a soluble form by sonic vibration of rat-liver mitochondria A similar method has been used to obtain an enzyme preparation from *Corynebacterium diphtheriæ*[21]

When a mitochondrial preparation from horse-heart[22] is treated with *n*-butyl alcohol, almost quantitative recovery of the succinic dehydrogenase is obtained in the clear aqueous layer, as follows The precipitate at $p$H 5 6 is washed with cold distilled water or 0 001 $M$ sodium bicarbonate solution, adjusted to $p$H 7 5-8 0 with 0 02$M$ sodium bicarbonate solution containing 0 85 per cent sodium chloride, and stirred thoroughly with excess *n*-butyl alcohol at low temperature (0 to −2° C ) The emulsion is held at this temperature for ½–1 hr , and occasionally stirred to promote lipid extraction After centrifuging at low temperature, the clear aqueous layer containing the enzyme is removed and dialysed at 0° C against 0 01 $M$ sodium bicarbonate and afterwards against distilled water For complete recovery of the enzyme the extraction is repeated

Preliminary fractionation with ammonium sulphate has yielded very active preparations as determined spectrophotometrically by reduction of potassium ferricyanide The enzyme, which has also been obtained in solution from other animal tissues and from yeast, is being further purified and its relation to the cytochrome system is being studied

*Other Dehydrogenases* Mitochondrial preparations from ox kidney and liver and rabbit skeletal muscle, and homogenates of rabbit brain, have been treated with *n*-butyl alcohol, and a number of other dehydrogenases, formerly recognized only in association with insoluble particles, have been obtained in solution Particular attention is being paid to the pyruvic, choline and α-glycerophosphate dehydrogenases

*Xanthine Oxidase* Treatment of the milk protein with ether[23] and digestion with pancreatic lipase[24] have previously been used to free this enzyme from associated lipid material During the preparation of alkaline phosphatase of milk using *n*-butyl alcohol, a red-coloured fraction was obtained. This showed an absorption spectrum similar to that of xanthine oxidase, and had xanthine dehydrogenase activity, although the intensity of colour, which was entirely reducible with sodium hydrosulphite, suggested association of other material

### Transaminase

A transamination reaction between phenylpyruvic acid and L-glutamate has recently been described and shown to be strictly associated with insoluble particles of rat liver[25] By treatment of a washed homogenate of calf-liver with *n*-butyl alcohol, a clear solution containing the transaminase system of the insoluble particles has now been obtained

### Esterases

*Insect Esterase* Treatment with *n*-butyl alcohol has been employed for the purification of an esterase hydrolysing ethyl butyrate and occurring in meal-worm larvæ[26] The crushed larvæ contain considerable lipid which is readily soluble in cold *n*-butyl alcohol, thus permitting aqueous solution of the enzyme.

*Intestinal Cholinesterase* The enzyme of calf intestinal mucosa[27] may be obtained in solution by *n*-butyl alcohol treatment, and this method is probably applicable to the separation of cholinesterases from brain and other tissues

### Crystalline Proteins

During acetone fractionation of clear solutions obtained after treatment of calf intestinal mucosa, liver and kidney with *n*-butyl alcohol followed by prolonged dialysis against distilled water, several proteins have been obtained as crystals The possibility of some of these having enzymic activity has not been eliminated A protein obtained from calf liver at the 30–33 per cent acetone fraction as slender needles, after recrystallization gave positive tests for hexosamine and may be a glycoprotein.

## Discussion

The above results obtained with a wide range of enzymes associated with insoluble materials indicate that *n*-butyl alcohol is an ideal solvent for the separation of biologically active proteins The specific action is largely due to the removal of lipids, particularly of phospholipids alkaline phosphatase and xanthine oxidase of milk are both associated with such insoluble material , animal tissue mitochondria contain up to 40 per cent (dry weight) of lipids, most of which are phospholipids[28] , while pea seeds, yeasts and bacteria may contain similar large amounts All these materials have been successfully treated with *n*-butyl alcohol, and active enzymes obtained in clear solutions

The solvent action of the two-phase system for organic esters, particularly phosphate esters, is also probably of importance Considerable organic phosphate is found in the residue obtained by distillation of *n*-butyl alcohol used for extraction of milk, calf-liver and certain mitochondrial preparations It is conceivable that these esters are closely bound with lipid in maintaining structural integrity and controlling permeability of cellular membranes, so that their removal enables release of certain proteins into solution

The straight-chain configuration apparently favours aqueous solution of enzymes, perhaps through interaction with the protein side-chains, since the *n*-butyl alcohol is superior for this purpose to both the *iso*- and secondary butyl alcohols The latter are also more toxic to enzymes For promoting protein solution the completely water-miscible propyl and lower alcohols are relatively ineffective, as are the amyl and higher alcohols of low water-solubility, although the two-phase system of water and alcohol appears to be essential for satisfactory treatment of most wet preparations

A specific ability of *n*-butyl alcohol to induce separation of lipoprotein complexes has previously been observed during an investigation of the tanning process in the insect cuticle[29] Evidence from this work suggested that *n*-butyl alcohol competes for the polar side-chains of the protein, so that the alcohol effectively replaces displaced lipids Such a competitive action may well be of importance in causing dissociation, not only of lipoprotein complexes but also of protein–protein complexes, and thus in favouring ready separation of enzymes

The interaction of the alcohol with the enzymes in solution is influenced by temperature, hydrogen ion concentration, ionic strength, and specific ion effects, as already shown for other organic solvents used for enzyme[6] and protein purification[30] The occurrence of crystalline proteins, as previously noted, confirms that denaturation has been considerably eliminated in the methods described, which contrast with the protein-denaturation procedures employing chloroform together with butyl and higher alcohols for the separation of mucopolysaccharides and mucoids[31]

The relative importance of the several factors mentioned is now being examined in detail to determine the mechanism of action of *n*-butyl alcohol and to permit of a more fundamental approach to the problem of enzyme solubility

The enzymes so far obtained in solution are being further purified and intensively studied in this Department, while the work is being extended to the separation of other enzymes of mitochondria, particularly those of the cytochrome system and citric acid cycle Apart from the evident advantages of study of these enzymes in solution and in purified preparations, it is apparent that the removal of large amounts of inactive materials, especially as found in certain plant tissues, may permit of *in vitro* demonstration of reactions at present only recognized in intact tissues or complete organs Undoubtedly much of the material removed by proper treatment with *n*-butyl alcohol could effectively inhibit certain enzymes in homogenates The comparatively ready extraction of proteins from yeast and bacteria treated with *n*-butyl alcohol at low temperature suggests the value of the method in obtaining cell-free enzymes from these organisms

While the method has been presented in some detail as applied to enzyme proteins, the possible use for the purification of other biologically important material is apparent Lipoproteins still present many problems connected with lipid association Application of *n*-butyl alcohol to the purification of the lipoprotein complex of lung is being investigated Hormone purification and steroid metabolism are other fields in which this technique may prove of value

I wish to thank Dr M Dixon for his encouraging interest and advice throughout this work, and Dr G Weber for helpful discussion on physico-chemical aspects I am indebted to a number of fellow-workers, particularly to Mr F J R Hird, for determining enzyme activities of certain preparations

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# JUBILEE OF THE SCIENCE MASTERS' ASSOCIATION

By G FOWLES

Chairman of the Association, 1940–45

THE Science Masters' Association celebrates its jubilee at the annual meeting being held in London during January 2–5 A commemorative dinner has been arranged at which many distinguished guests will be present

At the time of its foundation in 1900, membership of the Association was open to masters in public schools only However, in the eventful year 1918 the more progressively minded of the Committee came to the conclusion "that we owe it to the good of the nation to accept members from other types of school" In 1919, against much opposition, these men of vision won their point Rarely has such a democratic gesture proved so great a success The Association grew rapidly, the membership, less than 350 in 1919, had by 1939 risen to 2,600, in all directions there was recognition and welcome The universities, old and new the great scientific institutions and the leaders of industry alike, offered help and hospitality In turn, a succession of the leading men of science in Great Britain willingly accepted office as president and gave of their best Probably the single-minded aim of the Association, "to promote the teaching of science in schools", and the absence of trade union status and outlook and of any ulterior motive, had something to do with this, for it allowed public men and officials to attend the meetings and express their views Prominent among such regular visitors in the early 'twenties were Sir Richard Gregory, Sir Harold Hartley, and Profs H E Armstrong and A Smithells With their scholarship, their wider outlook and their warm attitude to the cause, their very presence at the conferences did much to raise the level of discussion and to broaden the outlook From the beginning, H M inspectors of schools were enthusiastic and helpful members The social contact permitted of informal talks which made official negotiations all the smoother In recognition of their friendly help, the Association has made four of their number honorary members E G (now Sir Graham) Savage, F B Stead, C J R Whitmore and A R Marshall

Since it is generally recognized that science is a dominant factor in the world of to-day, teachers instinctively realize that their attitude to it and to its teaching is of vital significance Yet science is a comparatively new subject in the schools The opportunity, therefore, of exchanging ideas and experience and of discussing methods of teaching afforded by the Science Masters' Association furthered its rapid growth Still, I believe that much of the present prosperity is due to the sound planning of the early leaders and their successors On four of these the Association bestowed its greatest honour each in his day filled the office of president They are Archer Vassall and C L Bryant, both of Harrow, C E (now Sir Cyril) Ashford of Dartmouth, and G H J Adlam of the City of London School These pioneers took a large share in building the two pillars of the Association, namely, the annual conference and the Association's journal, the *School Science Review* The latter owes much to the ability and devotion of its founder and first editor, G H J. Adlam The first issue, a booklet of 32 pages, appeared in 1919, the sixty-fifth, issued in 1939, contained 160 pages of reading matter Adlam was responsible for the first 103 numbers, and on his death in 1946 Spenser R Humby, of Winchester, was appointed editor All are pleased that while he retains the arrangement and keeps to the tradition of Adlam, he from time to time adds ideas of his own Most of the contributions are by members, but, when necessary, outside specialists are called upon to give expositions of difficult problems and of new advances In addition, the journal contains the presidential and other addresses, records of meetings, descriptions of school-made apparatus and of new experiments Those experiments recorded in the journal which seemed worthy of perpetuation have been suitably arranged in book form, so far, five of these "Science Masters' Books" have been published

Adlam's achievement in raising the *School Science Review* to the foremost place among journals of its class was so remarkable and so beneficial to science teaching that news of it spread afar In 1934, when his work was recognized by the award of the O B E, the Association was indeed proud Hundreds of members helped Adlam by writing articles, reviewing books, giving specialist advice and answering the questions of correspondents If from these I single out for remembrance the name of Bernard Neville of William Ellis School, I am sure none would demur Neville had a brilliant brain, and his physical affliction—he was a cripple—seems to have imbued him with a more than ordinary desire to serve his fellow-men.

The annual conference of the Association, usually held in the Christmas holidays, lasts for three days The president delivers his address and well-known science specialists give lectures, so that the conference becomes in part a refresher course Members exhibit school apparatus and show novel experiments and devices The Committee arranges discussions and visits to places of scientific interest. Publishers and instrument makers display their wares and demonstrate the working of new apparatus Opportunities for social contacts and for informal discussions abound The many who attend these conferences speak appreciatively of the stimulation and enjoyment they bring Among those attending the Jubilee Conference are the president, Sir Robert Robinson, the Dean of St Paul's, who is to give an address on "Knowledge, Religious and Scientific", A H T Glover, who is to deliver the Science and Citizenship Lecture, and Profs C K. Ingold, C A Coulson and J Z Young

The Science Masters' Association has already done much good work, still more work and difficult problems lie ahead These latter include the problem of science for the classical sixth form, the perennial question of the admission of women members, the role of the broadcast and the film strip in schools, and the machinery for running the Association The recent Education Act created the secondary modern schools, and teachers in them were immediately welcomed into the Association and offered the help of its accumulated experience In a few years time, this new class could easily outnumber the present members and determine the policy of the Association—a problem indeed Yet I look to the future with confidence In H P Ramage, of Gresham's School, Holt, we have a leader of tried worth Already in one office or another he has served for fourteen years During the War he did more than any other to keep the Association in being, it is fitting that in its jubilee year he should be chairman of the Association

# NEWS and VIEWS

## Unanswered Questions

A NEW experimental venture in the information field has recently been undertaken by the Intelligence Division of the Department of Scientific and Industrial Research A bulletin entitled *Unanswered Questions*, the first two issues of which have so far appeared, is being made freely available to interested organizations and individuals in Great Britain and overseas The purpose of the new bulletin is twofold As the title suggests, it is hoped through the medium of *Unanswered Questions* to obtain answers to specific scientific and technical questions when the normal processes of searching have apparently failed Readers of the bulletin are invited to supply any information which may help to answer questions listed in the bulletin and also to submit questions of their own Where the questions can be answered from sources of information known to the Department, the inquirer is put in touch with the source in the normal way

Fourteen questions were listed in the first number of the bulletin, and some information was quickly received on eight of these Attempts were then made to discover why the original inquirers had failed to find the answers It is hoped that by studying a number of questions in this way it may be possible to collect data on the adequacy of existing methods for disseminating information This is the second and perhaps more important purpose of the new bulletin The success of this experiment depends of course, on the supply of questions It is hoped, therefore, that all who have scientific and technical questions which have not been answered by the normal process of searching will send them to the address given below The source of any question is not disclosed Copies of *Unanswered Questions* may be obtained free of charge from the Department of Scientific and Industrial Research, Intelligence I, Charles House, 5 11 Regent Street, London, S W 1

## Industrial Time-Study Methods

As part of its programme of research into practical problems, the Nuffield Foundation is sponsoring an independent and disinterested scientific investigation into the techniques of stop-watch time-study practised in industry to-day A steering committee of physiologists, psychologists, statisticians and experts in management has been appointed, under the chairmanship of Sir Frederic Bartlett, to guide the inquiry , and Mr Winston Rodgers, head of the Department of Industrial Engineering at Acton Technical College, London, W.3, has directed the first stage of the investigation, now completed This stage was confined to testing the consistency of results obtained from existing methods of stop-watch time-study An experiment was designed, and carried out at Acton Technical College, whereby a group of time-study practitioners, employing conventional time-study techniques, were set to establish time-values for the same operations The results of this experiment have proved conclusively that, working under laboratory conditions with variables as far as possible reduced and controlled, the final time-values set by the practitioners showed a high degree of inconsistency In the light of these results, the steering committee is planning further work on the inquiry, with the long-term objective of evolving scientifically valid principles of work-measurement, as an alternative to existing practices It is not intended, at this stage, to publish details of the results of the laboratory experiment at Acton Technical College, though it is likely that they will form part of any final report on the inquiry that may be produced Mr Winston Rodgers will be willing to give more detailed information on the conduct of the experiment to those who may be interested

## Social Sciences Research Register

IN the social sciences it is difficult for the research worker and those concerned with the direction and administration of research to keep in touch with the development of ideas and trends in this field, or to avoid duplication with work being carried on elsewhere The boundaries of the social sciences are undetermined, and the data are scattered, much, for example, being the by-products of administration or to be found only in the archives and documents of public, semi-public or private organizations of all kinds. The "Register of Research in the Social Sciences in Progress and in Plan, No 7 1949–50, with a Directory of Research Institutions", prepared annually by the National Institute of Economic and Social Research under the editorship of Feodora Stone (pp 174 , London Cambridge University Press, 1950 , 15*s* ), therefore serves a useful purpose by providing a catalogue of research in progress at universities and research institutes, or which is being carried out by research groups or the learned and professional societies. Though it cannot hope to be exhaustive, and though it does not cover the research of private persons working on their own, or of commercial, industrial, political and similar bodies, the catalogue of work in progress is nevertheless very impressive, a total of 1,265 pieces of research being recorded and described There is also a useful directory of research institutions, giving essential information on nearly sixty organizations The register includes particulars of the work of research students proceeding to the Ph D degree, and this should prove a useful feature for those responsible for the work of postgraduate students The volume is well indexed, there being separate indexes for institutions, names of research workers and subjects of research

## Productivity and Management

IN his address on "Productivity", at the recent annual general meeting of Lever Brothers and Unilever, Ltd , Sir Geoffrey Heyworth made a valuable and practical contribution by describing the experience of his firm in tackling this problem Dealing with the human factor in productivity, he emphasized that wherever individual performance is inadequate, it is wise to look at the methods of supervision in some detail Day-to-day procedure and the level of understanding on the part of supervisors may vary considerably In the experience of his firm, he stated, a good manager's efforts to increase efficiency, after mutual consultation, are scarcely ever frustrated by resistance from the workers Neither workers, nor office personnel, like to work long hours, but while they are on the job they are generally willing to work Sir Geoffrey's firm is in a position to compare conditions in different countries because of its manifold activities, but it has not found any important differences between the workers of various European nationalities as far as willingness to work and potential performance are concerned Generally speaking, there are two motives for the acceptance by workers of production study namely, that it saves energy and that it brings in extra money It follows that the worker must be guaranteed that his wage will be maintained even if the amount of physical effort required is less than was necessary before the improvements were effected. The acceptance by all concerned of any new work tasks is vital and can only be achieved by explaining in detail to everybody exactly how the measurements have been arrived at, no trouble is too much to take to ensure full understanding.

## British Instruments for Radioactive Measurement

The Scientific Instrument Manufacturers Association, in conjunction with the Atomic Energy Research Establishment of the Ministry of Supply, have prepared an illustrated brochure describing the principal instruments required for investigations using radioactive substances that are manufactured in Great Britain The rapid developments in this field during the past five years are emphasized by the large number of instruments recorded in the thirty-odd pages of the catalogue The catalogue is prefaced by a short description of radioactive measurement techniques and followed by advertisements of consultants in this field The index tabulates nearly forty kinds of instruments, principally electronic, many of which are now manufactured by more than one supplier The brochure shows that Great Britain can offer a range and variety of such instruments which will compare favourably, both in cost and performance, with any competitor This catalogue is of particular importance to overseas consumers contemplating purchase in Great Britain of equipment for radioactive measurements For this reason, it is unfortunate that full technical specifications and performance data for each instrument are not provided Many instrument manufacturers still fail to achieve a clear and factual, and concise but comprehensive, specification of their products The rapid development in instrumentation in this field encourages one to hope that further editions will be issued The brochure is available free of charge from the Scientific Instrument Manufacturers Association, 17 Princes Gate, London, S W 7

## Exploration of a Coast-line of the Antarctic

One of the last remaining gaps in the known Antarctic coast-line was the south-western coast of the Weddell Sea Various attempts have been made to reach this by sea, but it is now realized that the currents of that Sea pack the ice against the coast and prevent any access, at least without extreme peril to the ship This stretch from about lat 68° S to lat 70° S, the work of the joint sledge journey of the Falkland Islands Dependencies Expedition and the United States Antarctic Research Expedition, is shown in a map, accompanying an article by Mr D P Mason, in the *Geographical Journal* of April–June this year Large glaciers seem to pour into deep indentations, and the Larsen Ice Shelf continues in a narrow form well to the south From the base at Stonington Island in Marguerite Bay the route was first across the peninsula of Graham Land and then southward over the shelf ice The leader had with him A R C Butson, of the Falkland Dependencies Survey, and two members of the American expedition This part of Antarctica had previously only been roughly surveyed, and to some extent incorrectly, from the air Air transport was of service to the expedition in carrying supplies, but the most important exploration was in surface work

## Zoological Publications from Victoria University College, New Zealand

The Department of Zoology of Victoria College, Wellington, New Zealand, has recently commenced a series of zoological publications in the form of individual pamphlets The first six of these, No 1, November 1, 1949–No 6, May 31, 1950, are now to hand They deal respectively with a new leech, new species of Ciliata, the Ctenophores, the Kirk collection of sponges, blood parasites of birds and new bugs (Hemiptera, Homoptera), and they vary in length from seven to twenty pages The printing throughout is of a high order, and the illustrations, whether text-figures or plates, are quite adequate The contents mainly deal with new species or the amplification of information concerning previously described forms, the exception being that dealing with sponges This deals with the collection of sponge material, either whole specimens or slides, made by the late Prof Kirk While most of them are New Zealand species, some material is from outside sources, and of this some derives from the *Challenger* collection worked out by Prof A Dendy It has made possible the establishment of a number of type specimens, holotype, syntype and merotype, as well as providing additional data on the localities of collection One detail that calls for note is whether these publications will be regarded as establishing priority in nomenclature under the international rules, since they carry no indication of price or availability In view of their excellence and usefulness, it would be a pity if they were considered to be invalid

## Experiments at the Grassland Research Station

A bulletin on "Experiments in Progress 1950" has been issued by the Grassland Research Station from Drayton, Stratford-on-Avon, Warwickshire The Station took over the work and functions of the former Grassland Improvement Station, as from October 1, 1949 (see *Nature*, 163, 477, 1949) New headquarters are being established at Hurley, Berkshire, but most of the experimental work listed in the bulletin has been carried out at Drayton The experiments in progress include some welcome new features such as the investigation of the much-neglected fungus diseases of grassland Some useful results obtained in earlier years are included in the publication Yields of various grass strains for hay, grazing, silage and winter keep are compared and related with live-weight increases under stock The relative yields of dry matter per acre under different methods of management are also tabulated Many of the results are records which will become increasingly valuable as the years pass, but the bulletin indicates a large amount of useful long-term work soundly established.

## Marine Radar for Harbour Use

A note on harbour radar services, based on an article in the *Journal of the Franklin Institute*, was published in *Nature* of September 30, p 544 Dr J B Warren, of the Department of Physics, University of British Columbia, Vancouver, has provided some additional information He states that an Admiralty Pattern 268 was installed at Halifax, Nova Scotia, in 1946, and in May 1949 the National Research Council of Canada installed an equipment on the centre of the Lions' Gate Bridge across the First Narrows in Vancouver Harbour. A description of this installation by W J Mooney appeared in *Harbour and Shipping* (Vancouver) of January 1950

Briefly, the radar consists of a much modified 268 model, that is, 3-cm wave-length with 1/4 micro-second pulse, operating into twin synchronized scanners placed on each side of the bridge, which give a beam-width of 1¾°, with a 12-in plan-position display

## Reference List of Microfilms and Microcards

THE General Reference and Bibliography Division of the Library of Congress at Washington has issued a selected list of references on "Microfilms and Microcards. their Use in Research", compiled by Blanche P McCrum (pp 81, Washington, D C Library of Congress Card Division, 1950, 55 cents) Its purpose is to indicate the sources from which may be gained an understanding of the history, development, spread and present utility of microfilms and microcards; but the list is not designed to appeal to the highly specialized interests of professional photographers and technicians, or to contribute to the literature of library administration in this field References to developments in countries other than the United States are incidental rather than comprehensive, but the activities of the Royal Society Scientific Information Conference and of Aslib in this field are well covered Part 1 of the list is limited essentially to books, monographs, bibliographies, catalogues and to periodicals devoted to the subject Part 2 includes articles published in periodicals since January 1, 1946 A brief topical index and a key to symbols are included

## Library Binderies

THE Library Association has issued as its Pamphlet No 3 a highly practical pamphlet on "Library Binderies" (pp 40+4 plates, London Library Association, 1950, 3*s* 6*d*, 2*s* 9*d* to members). Mr. James Cranshaw, formerly chief librarian, Kingston-upon-Hull, contributes a foreword, and both he and the author, Mr R F Drewery, who succeeded him as chief librarian, emphasize the economies which the establishment of its own bindery can offer to a library, particularly in the saving of time, clerical, packing and accounting operations, and in the undertaking of minor operations in the way of labelling or numbering new books, and the provision of light-weight equipment for filing and pamphlet boxes and trays, book dummies and book troughs The pamphlet then gives a layout for an establishment handling at a minimum ten thousand volumes a year and indicates the staff and equipment required and the conditions which have to be satisfied under the Factories Act and by trade union agreement or rules and regulations laid down by the local authority Besides his practical advice on such matters and also on materials, tools and appliances, Mr Drewery deals carefully with the question of economics and points out that, since labour costs are very high (forming approximately seventy-five per cent of the total expenditure), it is of first-rate importance to ensure that the team of work-people are kept fully occupied at their own jobs Full realization of the advantages of a library bindery accordingly involves both the formation of a well-balanced team of work-people and careful planning and arrangement, so as to secure a continuous flow of work to the bindery which will keep the team continuously occupied The pamphlet quotes Mr Cranshaw's estimate at Eastbourne that at 1949 prices a small workshop, without any power-driven machines, could be set up for a capital cost of £1,100

## Grants for Field-work in Geology and Geophysics

THE Shell Petroleum Co, Ltd, is offering in 1951 a number of grants for postgraduate studentships in geology, at £375 a year, which will be in addition to those that have already been awarded These studentships will be for work leading to the Ph D degree, and the only terms are that, first, the subject of the thesis, based on field-work, shall bear some relation, in stratigraphy and tectonics, to the conditions of oil occurrence, and, secondly, that by preference the student shall work elsewhere than at the university at which he graduated, a principle which, it is felt, might be more widely adopted At the present time, Ph D. work in geology is being done by students from the Universities of London, Bristol, Leeds and Newcastle in areas as widely separated as the Welsh and Scottish borders, the Pennines and western Ireland There are, too, studentships in geophysics at the Imperial College of Science and Technology, London, and at Cambridge, but with the growth of interest in this subject, as, for example, at Birmingham, it is hoped to spread these studentships more widely A second part of the Shell Petroleum Co's plan consists in encouraging geological field-work by distributing £2,500 annually to the various university geological departments The grants are made primarily with the object of assisting undergraduate students to undertake individual mapping during the course of their study when there is no other source of funds, or for individual field-mapping out of term

## International Welding Congress

AN International Welding Congress will be held in London and Oxford during July 14–21, 1951. The Congress will include the annual meeting of the International Institute of Welding and its various Commissions, and is being sponsored in Great Britain by the five British member societies, namely, the Institute of Welding, the British Welding Research Association, the British Acetylene Association, and the Welding Sections of the British Electrical and Allied Manufacturers' Association and of the Sheet and Strip Metal Users' Technical Association The Congress will open in London on July 14 and will move on the following day to Oxford, where three colleges, Christ Church, Oriel and Somerville, will accommodate the visitors, who are expected to number between four and five hundred Meetings of the fourteen technical commissions of the Institute will occupy the first two days, and in the second part of the week there will be three open sessions for the presentation and discussion of papers, the sessions being on the welding of wrought light alloys, welding of bridges and allied structures, and present trends in British welding After July 21, facilities will be provided through the twenty branches of the Institute of Welding for members to visit works in all parts of Great Britain The secretary of the Congress is the secretary-general of the International Institute of Welding, Mr G Parsloe, and the office of the organizing committee is at 2 Buckingham Palace Gardens, Buckingham Palace Road, London, S W 1

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ERRATUM In *Nature* of November 25, p 898, the article entitled "Financial Incentives" had a footnote referring to a booklet "Organizing for Output" published by the British Institute of Management, 8 Hill Street, London, W 1 This reference should have been to "Wage Incentive Schemes" (pp 26, price 2*s* 6*d*) published by the same body

# SCATTERING OF ELECTROMAGNETIC WAVES BY ATMOSPHERIC TURBULENCE

By Dr E. C. S. MEGAW
Royal Naval Scientific Service

## Stellar Scintillation and the Spectrum of Turbulence in the Free Atmosphere

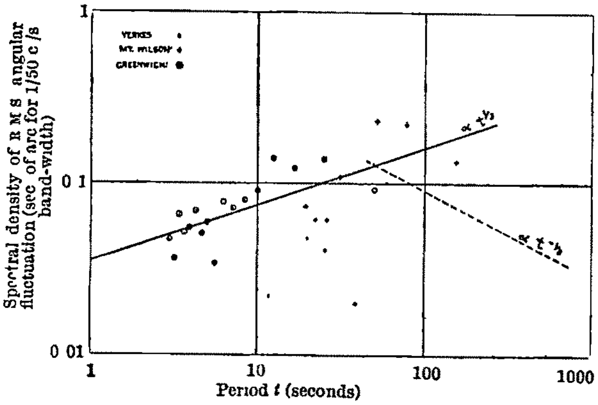
KNOWLEDGE of turbulent fluctuations in the atmosphere, whether of velocity or of other physical quantities, has not yet reached the point at which a representative statistical description can be discovered in the literature Although aircraft measurements of temperature, humidity and acceleration fluctuations have been briefly reported[1,2] and are of great interest, knowledge of the average properties of turbulence in the free atmosphere is almost totally lacking Recent developments in the statistical theory of turbulence, which may be expected to find application here, do not yet appear to have done so

Against this background a description of atmospheric turbulence derived from the twinkling of the stars may be of interest This was obtained in an investigation of the effect of fluctuations in refractive index on radio propagation beyond the horizon , this is referred to in the following communication[3] In an earlier unpublished study of the scintillation observed in centimetre-wave transmission over unobstructed paths, it had been shown by J M C Scott[4] that the radio observations were consistent in order of magnitude with the measure of refractive index fluctuation indicated by text-book descriptions of astronomical scintillation My treatment of the astronomical case is essentially an elaboration of Scott's discussion to provide approximate numerical values, taking account of the spectrum of the fluctuations and of the variation of mean air density with height

From the theoretical aspect a fundamental difficulty of atmospheric turbulence, viewed on a large scale, is that it has multiple energy inputs On the largest scale one may regard turbulent dissipation in the free atmosphere as a partial sink for energy on its way from the equatorial boiler to the polar condensers , but locally variable convection is an inevitable complication, as is the lack of statistical homogeneity through the surface layer. The approach throughout the present work has been in terms of the statistical simplicity which it was thought might obtain in the free atmosphere, noting that changes in intensity and spectrum through the surface layer would, on the average, probably have little effect on stellar scintillation, and that these changes might to some extent compensate one another in the radio scattering problem

The literature of stellar scintillation is considerable, but is widely scattered and evidently not well known , the recent controversy on the subject in *Nature*[5] would otherwise scarcely have been possible There seems to have been no comprehensive discussion since the Pernter-Exner monograph[6] appeared early in the century, and the literature is not entirely free from contradictions and confusions But the weight of evidence accumulated over the past hundred years leaves no doubt of the correctness of Newton's opinion that the twinkling of the stars is caused by variable atmospheric refraction Some representative references have been given in the recent discussion, particularly by Minnaert[7] As with the meteorological observations, satisfactory measuring technique (at least for brightness fluctuations) has only recently become available , but in this case the information does refer, in an integral form, to the whole thickness of the atmosphere The fact that the phenomena of astronomical 'seeing' (in the narrow sense) are known to vary with time and place, and to show some correlation with surface weather, might be thought to suggest that the effects measured are wholly produced in the surface layer There is much evidence to show that this is not so[8,9]. The faster fluctuations, which are obvious either to the naked eye or as blurring of telescope images, and which correspond to part of the small-eddy end of the spectrum, may, however, be much influenced by changes in turbulence near the ground

The information on angular fluctuation of star images available from measurement of photographic star trails at several observatories was first examined. This information relates particularly to the *large-eddy* end of the spectrum The accompanying graph shows fluctuation spectra obtained from Fourier analyses, kindly carried out by Mr N. F Barber at the Admiralty Research Laboratory, of measurements from Yerkes (40-in refractor) and Mount Wilson (60-in. reflector)[10], and from Greenwich (Cookson 7½-in floating zenith)[11]. The points for Greenwich are averages of corresponding components from two trails on the same plate, which may account for the smaller spread in this case , the others are from single representative trails (both a little above average in root-mean-square total fluctuation computed directly from the observations) The considerable spread in the points is scarcely surprising in view of the smallness of the sample which it was practicable to analyse , indeed, the measure of agreement between the three sets of observations is closer than might have been expected. The full line through the points is drawn with the slope ($\propto t^{1/3}$) which corresponds to the equilibrium spectrum derived by Kolmogoroff[12,13,14] for "locally isotropic" turbulence, with the assumption (which is plausible in this case,



Stellar scintillation spectra , angular fluctuation for zenith distance near 0°

Table 1 FLUCTUATION IN REFRACTIVE INDEX FROM PHOTO-ELECTRIC RECORDS OF BRIGHTNESS FLUCTUATION

| Source | Telescope aperture (in ) | Time constant (sec ) | R M S brightness fluctuation (per cent) | Zenith distance | Remarks | Derived $N'_0$ ($m^{-1}$) |
|---|---|---|---|---|---|---|
| Kron (1949) | 36 | 1 5 | about 1 | < 45° | Rough estimate from many records | 1 × 10$^{-7}$ |
| ,, | 12 | ,, | about 1 5 | ,, | | 1 |
| Stebbins (1944) | 4 | about 0 01 | 18 | | | 0 5 |
| ,, | 15 | ,, | 9 | about 40° | | 0 6 |
| ,, | 60 | ,, | 2 2 | | | 0 5 |
| ,, | 4 | 2 | 1 6 | | | 0 6 |
| ,, | 15 | 2 | 0 8 | | | 0 5 |
| ,, | 60 | 2 | 0 2 | | Doubtful reading | 0 4 |
| Kron (1950) | 12 | 0 2 | 1 5$_5$ | 0° | Extrapolated from records of 4 stars at Z D 8°–62° | 0 5$_5$ |

though it is probably not always correct) that the spectrum of refractive index fluctuation is the same as that of velocity fluctuation This slope is at least an acceptable representation of the trend of the observations, though the slightly different slope ($\propto t^{1/2}$), corresponding to the Fourier transform of the exponential correlation coefficient introduced by Taylor[15] in the earlier form of the theory, represents an equally good fit Although the probability that the ordinates at the long-period end of each individual spectrum are representative is rather small, each shows a tendency to decrease in amplitude in the region of $t = 50$ sec or more ; this is borne out by inspection of other trails of which a full analysis was not made While the true average trend of the spectrum at the long-period end is quite uncertain, a decrease as $t^{-1/2}$ (dashed line) for $t > 50$ sec is a possible representation in this region If, as appears to be appropriate here, a mean upper-wind velocity of 15 m /sec is assumed, these results suggest that the equilibrium spectrum extends to a largest eddy size of the order of 400 m It can be shown that this corresponds to an integral scale of turbulence[15] of the order of 100 m These figures appear reasonable, the first as being an order of magnitude smaller than the height of the equivalent uniform atmosphere, and the second in relation to meteorological estimates of mixing length[16] The true values evidently may be larger, but can scarcely be much smaller

Measurements of stellar brightness fluctuation have been made photographically[6], but have become really satisfactory only since the introduction of photoelectric photometry The only published records of this kind appear to be some examples given by Stebbins[17], which were intended for demonstration rather than analysis These have been supplemented by additional unpublished information kindly provided by Dr G E Kron[18] of Lick Observatory The recorded brightness fluctuations provide information particularly about the *small-eddy* end of the spectrum, and they are therefore greatly influenced by the telescope aperture and the time constant of the recording equipment The dependence of the root-mean-square value of the recorded fluctuation on both these factors has been calculated, this is usually likely to dominate the 'natural' (viscosity) cut-off of the equilibrium spectrum, derived by Heisenberg[14]

Table 2 FLUCTUATION IN REFRACTIVE INDEX FROM FOURIER ANALYSIS OF ANGULAR FLUCTUATION IN PHOTOGRAPHIC TRAILS

| Source | R M S angular fluctuation at Z D 0° | Derived $N'_0$ ($m^{-1}$) |
|---|---|---|
| Accompanying figure, assuming Kolmogoroff spectrum as represented by full line and terminated by viscosity at eddy size 0 1 m | 0 8$_7''$ | 1$_2$ × 10$^{-7}$ |

Note The consistency of the results from Stebbins's observations in Table 1 implies that the smallest' eddy size of the equilibrium spectrum is not much greater than 0 1 m An average figure of this order—perhaps rather less near the surface and rather more at great heights —is supported by much other evidence in the literature

A measure of the total fluctuation in refractive index has been derived from each of the available records of brightness fluctuation, and also from the average observed spectrum of angular fluctuation as represented in the graph The assumption is made that *all the observations can be accounted for by an average spectrum of turbulence which is a permanent characteristic of the atmosphere, and that this is, in fact, the Kolmogoroff spectrum* The consistency of the derived values provides a test—in principle sensitive, but limited here mainly by the nature of the observations available—of the truth or falsity of this assumption. The results are given in Tables 1 and 2 ; the derived measure, $N'_0$, is the root-mean-square fluctuation in refractive index gradient, referred to ground-level

In spite of the rather striking consistency of the final results, it would be premature to claim that the assumption italicized above has been justified until reasons for the spread (by about a factor 2) are definitely established (The figure given in Table 2 for root-mean-square angular fluctuation, for example, is almost certainly larger than the true long-time average, this is probably nearer 0 5″ from all the available evidence )

The assumption may, however, fairly be taken as a starting point in the problem which gave rise to this study The degree of statistical simplicity which this work has revealed also suggests that the principles of similarity, recently so fruitful in other fields, have an important contribution to make in atmospheric turbulence, in spite of all its complexities

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## Scattering of Short Radio Waves by Atmospheric Turbulence

Numerous measurements during the past fifteen years have led to the belief that the theory of diffraction around the earth gives a correct description of the propagation of radio waves beyond the horizon, provided (*a*) the waves are short enough to be unaffected by the ionosphere, and (*b*) the distribution of mean refractive index gradient is sufficiently like that of the so-called 'standard' atmosphere to be represented in the theory by a small modification of the earth's radius From experiments carried out a few years ago it appeared first probable[1], and later almost certain[2], that this conclusion was sometimes false when the distance was great enough in relation to the wave-length and aerial heights used In these experiments field-strengths too large to be accounted for by current theory were observed It was suggested by Pekeris[3] that their cause might be a scattering process in the atmosphere

I reached the conclusion that, in spite of apparent discrepancies, these 'anomalous' observations had a common cause, not in any exceptional condition of the atmosphere but in its permanently turbulent state and in the consequent fluctuation of refractive index A rough calculation was made (towards the end of 1948) of the field-strength to be expected beyond the horizon from atmospheric scattering alone, with results in good agreement with those reported in ref 1 This much-simplified treatment indicated that the scattered field strength varied as the $-3/2$ power of the distance and was independent of wave-length Afterwards the theory was extended to remove some of its more obvious deficiencies, a considerable study was made of available information relating to turbulence and to fluctuations of refractive index, and an experimental investigation was carried out with results outlined below

The three-dimensional fluctuations of refractive index, assumed statistically stationary, are supposed analysed into a spectrum of triply periodic components For a small interval of the spectrum a representative 'Fourier element' (a half-space-wave-length cube) is considered, and the field scattered by this element evaluated for the most favourable phasing in the three co-ordinates It has been assumed—with little justification beyond plausible analogy—that the appropriate space integration, with random phasing between Fourier elements, gives the correct contribution to the scattered field As it stands, this treatment leaves some doubt about the correctness of the final numerical coefficients, but it confers the great advantage of retaining the constants specifying a finite spectrum in the expression for the scattered field, after the final integration over the spectrum

The result of this analysis, in a form applicable to wave-lengths from a few decimetres to about 2 cm, is outlined here In general, when the distance is great enough for the diffracted field to be negligible, the ratio of the root-mean-square field-strength to the free-space field-strength at the same distance may be written

$$E/E_0 = Q\,N'\,K, \qquad (1)$$

where $Q$ is a function of the geometry, $N'$ is the root-mean-square fluctuation of refractive index *gradient* in an appropriate interval of height, and $K$ is a function of the spectrum of turbulence Units are: $Q$ and $K$ in $\mathrm{m}^{1/2}$, $N'$ in $\mathrm{m}^{-1}$, all lengths in metres A great simplification of the results is effected by restricting the discussion to small angles (beam-widths and scattering angles), and this appears always permissible in the wave-length range stated The geometrical factor is then given by

$$Q = (2/\pi^2)\,L^{-1/2}\,R\,\{1 - (d_0/L)\}^{-1}\,F\,(p, b), \qquad (2)$$

where $p$ is $2\theta/\alpha$ and $b$ is $\varphi/\theta$; $L$ is distance and $R$ is effective earth radius taking account of mean refraction which is assumed near 'standard', $d_0$ is horizon distance for given transmitter and receiver aerial heights which, if dissimilar, must be small enough to make $d_0 \ll L$, $\theta$, $\varphi$ are elevation and azimuth semi-beam-widths, if not the same at transmitter and receiver, it is permissible to take the geometric mean of the two $\theta$'s, provided they are of the same order, and the lesser of the two $\varphi$'s, $\alpha$ is angle between tangents to the earth from transmitter and receiver aerials, in the vertical plane through the aerials which is equal to $(L/R)\,\{1 - (d_0/L)\}$

Here $F$ is a numerical factor given by a rather complicated volume integral in which a dependence on wave-length, atmospheric attenuation, and the variation of intensity and spectrum of turbulence with height, may all be ignored *for the stated wave-length range* without serious error A few values of $F$ have been obtained numerically

| $p$ | 0 1 | 0 3 | 1 | 3 | 10 | 30 | 100 | |
|---|---|---|---|---|---|---|---|---|
| $b = \frac{1}{4}$ | 0 014 | 0 059 | 0 21 | 0 46 | 0 72 | 0 85 | 0 88 | $F\,(p, b)$ |
| $b = 1$ | 0 028 | 0 12 | 0 37 | 0 66 | 0 83 | 0 88 | 0 88 | |
| $b = 4$ | 0 055 | 0 19 | 0 46 | 0 72 | 0 85 | 0 88 | 0 89 | |

For small distances—usually less than 100 miles—the difference of $F$ from unity, and probably also the variation of $N'$ with height, are not of much importance in view of other approximations At larger distances both lead to an increasingly rapid decline in scattered field, to calculate this a known or assumed form for $N'(h)$, and hence $N'(L)$, must be introduced The appropriate value of height $h$, which in any particular case can be obtained by straightforward but tedious numerical integration, is given roughly by

$$h = (L^2/2)\,[(1/4R)\,\{1 - (d_0/L)\}^2 + 0\ 8 \times 10^{-6}\theta], \qquad (3)$$

in which the first term is simply the height of the earth-tangent intersection for small or equal aerial heights, this is a lower limit, since the contribution to the scattered field from below the horizon can be shown to be negligible

Since the spectrum of atmospheric turbulence, discussed in the previous communication[4], covers a large range of eddy sizes (of order $10^3$), the polar function of an elementary scatterer cannot be described by a single simple expression over the whole range of the spectrum and of position in space In (at least) the conditions assumed here, the transition between the regions of validity of two simple forms of scattering function can be represented without serious error as an additional form of spectral cut-off With the spectrum of ref 4, assuming that changes with height may on the average be ignored, the factor $K$ in equation (1) becomes

$$K = 2\,a_s^{2/3}\,a_\gamma^{-1/6} = 2\,a_s^{2/3}\,[(2L/R)\,\{1 - (d_0/L)\}]^{1/6}\,\lambda^{-1/6}, \qquad (4)$$

where $a_s$ is the 'smallest' eddy size of the equilibrium spectrum (taken as 0 1 m); $a_\gamma \equiv \lambda/2\alpha$ is the eddy size at which the cut-off representing the change in scattering function sets in; and $\lambda$ is the radio wave-

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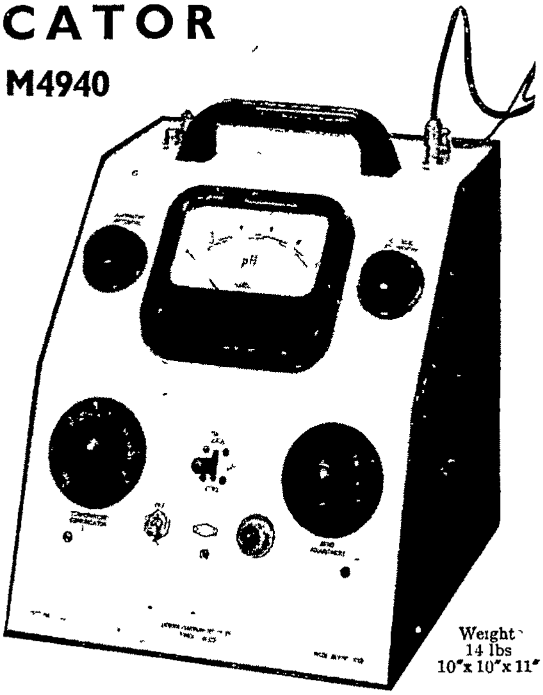

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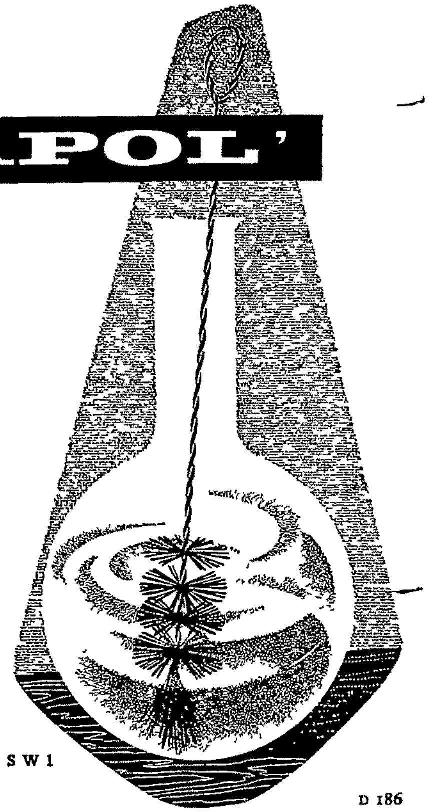

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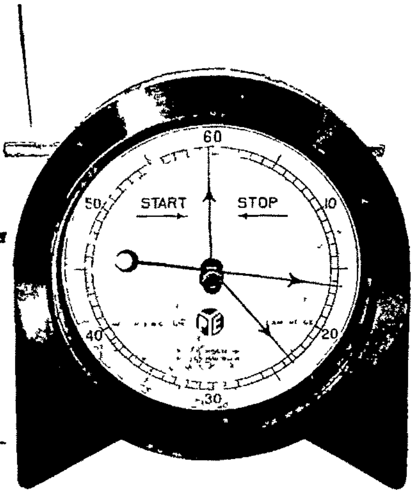

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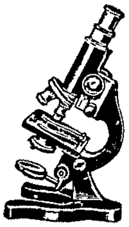

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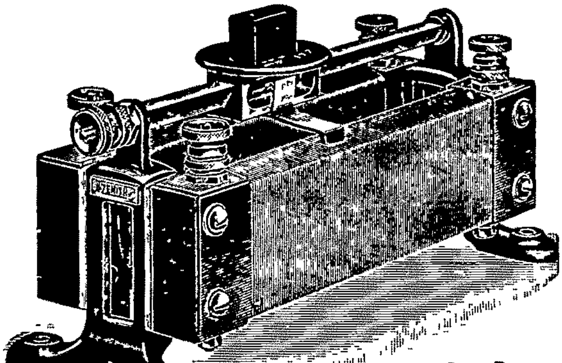

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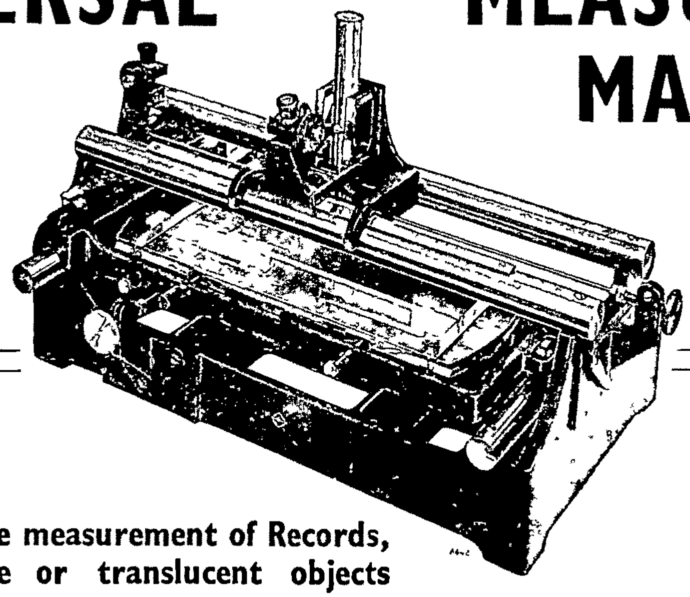

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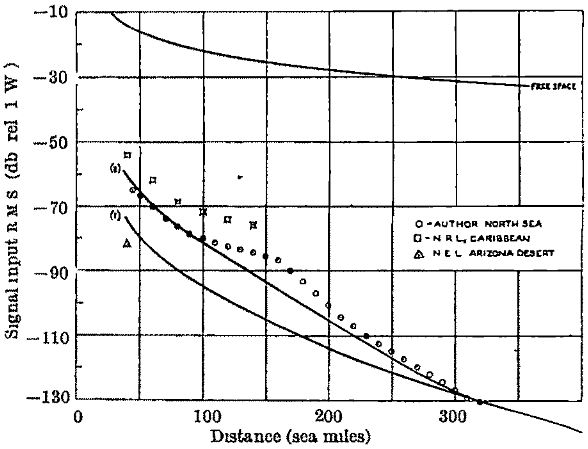
**2a Southampton Row, London, W.C.1**

length, which (in the present approximation) makes its only appearance here It should be noted that $a_s \ll a_1$, where $a_1$ is the 'largest' eddy size of the equilibrium spectrum (order of 400 m ), is implicit in the evaluation of the product $N'K$, and so in equation 4. If the root-mean-square fluctuation in *refractive index* is $N$, in units of $10^{-6}$, $N \approx 3\ {}_6 N'$ for the spectrum assumed, a result which depends appreciably on the (uncertain) termination of the large-eddy end of the spectrum

An independent theoretical solution of this problem has recently been published by Booker and Gordon[5] Their analysis, though starting from a different and essentially more rigorous point of view[6] and leading to expressions superficially unlike those given above, has much in common with mine The conclusions reached show some striking differences, these, however, chiefly reflect differences in the sources of information on atmospheric turbulence initially relied upon in the two treatments rather than the differences in analysis Corresponding expressions for the scattered field can, in fact, be shown to be formally identical, but Booker and Gordon's results gain their simplicity from the use of an infinite spectrum—represented by an exponential correlation coefficient of unrestricted argument, which calls for some caution in application—and this precludes a straightforward comparison of numerical coefficients With plausible limits to the spectrum, comparison in the long-range radio case suggests that my numerical coefficient is too small by a factor near 2 The material difference, however, apart from refinements and questions of generality, is that Booker and Gordon's final comparison of theory and observation appears to imply an integral scale of turbulence at heights up to about a kilometre, which is about 1,000 times too small for that height

The results of field-strength measurements made at 10 cm wave-length during six passages across the northern North Sea in the summer of 1949 are shown in the accompanying figure, these extended over a period of two and a half weeks in which a wide variety of weather conditions was encountered Those parts of the original signal records which appeared from characteristic changes in the form of the record, supplemented by meteorological evidence, to be definitely influenced by super-refraction—which occurred to a marked degree part of the time—have been omitted The circled points lie on the smooth curve considered to represent the remaining observations best, 90 per cent of them were within ± 5 db of the curve The observations of ref 1 are represented by the square points These define the lower envelope of a composite plot, Fig 10 of ref 1, of observations on 9 1-cm wave-length in the Caribbean Sea, it is considered that this curve approximates to the condition of negligible super-refraction The single triangle point at 40 miles represents daylight observations in the Arizona Desert[2] at the same wave-length, for small aerial heights The discrepancy between the three sets of observations is reduced if allowance is made for instrumental differences, it is further reduced if allowance is made, according to any plausible assumption, for the differences in specific humidity between the three areas

The full curve 1 is obtained from the theory, using the fluctuation spectrum (assumed independent of height apart from a change in root-mean-square value proportional to the gradient of air density) derived from the astronomical observations, an allowance for



Scattered field at 10 cm wave-length comparison of observed and calculated results
Curves calculated, points observed

the greater refractive index of water vapour at radio-frequencies is included As expected, this curve agrees best with the observations at great distances, that is, when the scattering is solely from large heights in the atmosphere

In calculating the theoretical curve 2, the root-mean-square value of the fluctuating refractive index gradient near the surface has been increased to a larger value derived from radio (free-space) scintillation measurements, the corresponding value of $N$ (root-mean-square) is near that adopted in ref 5 The relative increase is assumed to decline with increasing height at a rate corresponding to the fall in average water-vapour content of the atmosphere

The similarity of slope of observed and calculated curves, particularly between 50 and 100 miles, is probably the most definite evidence of the adequacy of the theory, the close numerical agreement with curve 2 at the largest and smallest distances must be considered accidental. The 'hump' in the observed curve near 150 miles (at which distance the most important heights are in the cloud layer, about 1–2 km ) is thought to represent a real difference between the simple assumptions of the theory and the actual distribution of turbulence and refractive index Perhaps the most significant outcome is the apparent confirmation of the conjecture that turbulent scattering, at least of centimetre waves, represents a permanent, if slightly variable, modification of normal propagation beyond the horizon

In regard to dependence on wave-length, the observations on 3 2-cm wave-length in ref 2 indicate, perhaps not conclusively, a considerably faster increase with decreasing wave-length than that indicated by equation (4) The problem of scattering at metre wave-lengths, which is theoretically more difficult, and may well show less clear-cut characteristics in practice, has not yet been fully examined There is some indication that, allowing for the decrease in aerial directivity which commonly accompanies an increase in wave-length, the root-mean-square scattered field, expressed as a fraction of the free-space field, does not vary widely over the whole wave-length range in which it is observable The general similarity of unexpectedly high field strengths recently reported[7] at television wave-lengths and those recorded in the accompanying figure may not be entirely fortuitous It is, indeed, probable that turbulent scattering, as one factor among several, plays an important part in determining the signals received from high-power metre-wave transmitters at distances greater than about 100 miles [Aug 8

*Note added in proof* For further discussion of the value of the integral scale of turbulence see Proc IXth General Assembly, International Scientific Radio Union (Sept. 1950), in course of publication, and for a different conclusion regarding the smallest eddy size, cf. Batchelor, *Quart. J Roy Met Soc*, 76, 133 (1950). It is hoped that both these issues will shortly be clarified by direct measurement of the fluctuation spectrum

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[3] Pekeris, C L, *Proc Inst Rad Eng*, 35, 453 (1947)

[4] Megaw, E C S (see preceding communication)

[5] Booker, H G, and Gordon, W E, *Proc Inst Rad Eng*, 38, 401 (1950)

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[7] Bullington, K, *Proc Inst Rad Eng*, 38, 27 (1950)

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# DETECTION OF FREE HYDROXYL RADICALS BY HYDROXYLATION OF AROMATIC COMPOUNDS

By DR. GABRIEL STEIN and DR. JOSEPH WEISS
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THE existence of free hydroxyl radicals in the gaseous phase has been definitely established by the study of absorption spectra[1] Haber and Willstatter[2a] and Franck and Haber[2b] introduced hydroxyl radicals as intermediates in the mechanism of reactions in aqueous systems, particularly in the case of oxidation processes Hydrogen peroxide to which ferrous salt is added (Fenton's reagent) was employed long before it was realized that its action was due to the formation of free hydroxyl radicals which, according to Haber and Weiss[3], are formed by the reaction ·

$$H_2O_2 + Fe^{2+} \longrightarrow OH + OH^- + Fe^{3+}\cdot \qquad (1)$$

The presence of free hydroxyl radicals in this reaction has been confirmed by M G Evans *et al* [4a], who were able to show that this reagent can initiate the polymerization of suitable monomers This is a powerful method which can be used generally for the detection of various kinds of free radicals[4,5].

It is known also that the hydrogen-peroxide/ferrous salt reagent is capable of hydroxylating aromatic compounds with the formation of phenolic products[6] This reaction can be carried out under remarkably mild conditions, under which the normally inert aromatic compounds, for example, benzene, are not otherwise attacked We have been able to show that this reaction may be used for the *specific* detection of free hydroxyl radicals in different reactions Using benzene as the simplest case, the action of hydroxyl radicals leads to the formation of free phenyl radicals and phenol according to

$$C_6H_6 + \cdot OH \longrightarrow C_6H_5 + H_2O \qquad (2)$$

$$C_6H_5\cdot + \cdot OH \longrightarrow C_6H_5OH \qquad (3)$$

and of diphenyl

$$2\,C_6H_5 \longrightarrow (C_6H_5)_2. \qquad (4)$$

The formation of diphenyl[6b] confirms the free radical nature of this reaction, as shown also by Merz and Waters[6d]. Using this method, we have established the presence of free hydroxyl radicals in the action of ionizing radiations (X- and gamma-rays, neutrons, alpha-particles) on dilute aqueous solutions[6b,7], where the radicals are formed according to the net process[8] :

$$H_2O \rightsquigarrow H + OH \qquad (5)$$

The phenol and diphenyl formed when water is irradiated in the presence of benzene can be isolated under suitable conditions, or detected by various colour reactions The same type of reaction may be carried out using other aromatic compounds as substrates, such as benzoic acid, nitrobenzene, etc.[6b,7,9]

We have also applied this method to the study of photochemical reactions in aqueous solutions, where hydroxyl radicals are formed by the photochemical decomposition of water in the presence of ions such as uranyl or ceric[9] according to

$$UO_2^{2+}.H_2O + h\nu \longrightarrow (UO_2^{2+}\,H_2O)^* \longrightarrow UO_2^{+} + OH + H^+ \qquad (6)$$

and

$$Ce^{4+}\,OH^- + h\nu \longrightarrow (Ce^{4+}\,OH^-)^* \longrightarrow Ce^{3+} + OH. \qquad (7)$$

Previously, it has been shown[9b] that in the case of ceric salts molecular oxygen is given off With the polymerization technique, the occurrence of free radicals was established by Evans and Uri[4b] in the case of the photochemical decomposition of water by ferric ions, and by Melville and Whyte[4c] using uranyl salts In our experiments[10], the formation of phenolic compounds could be shown even on irradiating, with visible light, solutions containing ceric or uranyl salts and an aromatic compound[4d]

Thus, in such widely different reactions as the catalytic decomposition of hydrogen peroxide, the action of ionizing radiations on water, the photochemical decomposition of water by certain metal ions involving single-electron transfer processes, and apparently also some well defined cases of electrolytic oxidations[11], all the available evidence is in agreement with, and can be explained most easily by, the assumption of a mechanism involving free hydroxyl radicals

This comparison is based on the qualitative analogy between the various reaction mechanisms The problem can be taken a step further if in addition a quantitative study is made of the hydroxylation of different monosubstituted benzene derivatives, where the ratio of the isomers formed under various conditions is accurately determined Agreement in the proportions of the hydroxylated *ortho*-, *meta*- and *para*-isomers should give a more rigorous test as to whether the same mechanism is operating in two different cases Applying this criterion it might be possible to approach the problem of certain processes *in vivo*, which may involve hydroxyl radicals or radicals of a similar nature as intermediates.

It has been known for about a hundred years that some aromatic compounds are hydroxylated in the human and animal body[12] Dakin[13] paid particular attention to some similarities between these products and those obtained by the action of hydrogen peroxide Haber and Willstatter[2a] gave the first discussion of the possibilities of free-radical reactions *in vivo* It is possible that aromatic hydroxylation is capable of contributing to the elucidation of this problem However, it would be very rash to conclude simply on the basis of the remarkable ease with which these reactions occur *in vitro* and from some qualitative similarity of the reaction products to those of the corresponding metabolic processes, that identical reaction mechanisms are involved in both cases

Different reaction paths, involving enzymes, might easily yield similar products without the intervention of radicals. It is here that the quantitative approach might help

In general, the positions in which a further substituent is introduced into an already substituted benzene ring and the relative proportions of the possible isomers formed depend on the existing substituent or substituents and the nature of the substituting agent There is no general agreement as to whether free-radical substituting agents should be subject to a directive action. If the directive action does not operate, all possible isomers should be formed in the statistically appropriate ratio , that is, in the case of a monosubstituted benzene derivative, further substitution should yield one *para*-isomer for every two *ortho* and two *meta* formed, independently of the nature of the existing substituent It has also been suggested[14] that in free-radical substitution the quinonoid structure of the transition state is of such importance that substitution will always be preponderantly *para* with some *ortho*. It is agreed, however, that free-radical substitution should be quantitatively different from substitution by ionic agents, and thus a quantitative investigation of the substitution ratios by reagents known to yield free hydroxyl radicals is therefore of considerable interest

The hydrogen-peroxide/ferrous salt reagent is not very well suited for quantitative investigations of this nature However, we have used this reagent as the basis of a quantitative comparison with the action of ionizing radiations, and using nitrobenzene as the substrate we have shown that, within experimental error, the ratios of the three isomeric nitrophenols formed in either of these processes are practically identical[6c,7b] In this case, where the existing substituent is the *meta*-directing $NO_2$-group, all three possible isomers are formed in approximately equal quantities, the formation of the *para*-isomer thus being favoured

We have now used the method of producing hydroxyl radicals by X-rays (which is particularly suited for quantitative work) to investigate the ratio of isomers in the substitution of benzoic acid and phenol Benzoic acid gave all three isomers in the ratio *p* *o* *m* approximately 10 5 2[7a,7d], whereas in the case of phenol no *meta*-isomer was found, the ratio *p* *o* being approximately 2 1 in neutral solution, and rising to approximately 8 1 in acid or alkaline solutions[7c] We have also investigated in some detail the effect of *p*H on the substitution ratios All these results show that *para* substitution is generally favoured and that the ratio of the isomers depends on the primary substituent in a manner which is quantitatively different from other types of substitution

To compare these results with experiments *in vivo*, reference can be made to the recent work of R T. Williams *et al* [15] on the metabolism of aromatic compounds. Some of their results and those of Lederer *et al.*[16] are not incompatible with the assumption of a free-radical mechanism *in vivo*, but more experimental results are needed before any definite conclusions can be drawn.

Even in those cases where there is quantitative agreement in the substitution ratios, it is by no means proved that hydroxyl radicals are actually operative *in vivo*. However, it would necessitate the assumption of transition states, which are effectively free radical in nature, though they may be formed on the surface of an enzyme, in the adsorbed state There is also the possibility that more than one type of mechanism may operate at various biological sites, and while dihydro-diol formation[17] may be the mode of action in one mechanism, at other sites free-radical substitution may operate Preferential conjugation, rather than hydroxylation of intermediates, must also be considered before further conclusions can be drawn in this important problem.

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[2] (*a*) Haber and Willstätter, *Ber* , **64**, 2844 (1931) (*b*) Franck and Haber, *Sitzb Preuss Akad Wiss* , 250 (1931)

[3] Haber and Weiss, *Proc Roy. Soc* , A, **147**, 332 (1934)

[4] (*a*) Baxendale, Evans and Park, *Trans Farad Soc* , **42**, 155 (1946). (*b*) Evans and Uri, Sympos Photochemistry of Dyestuffs, Soc Dyers and Colorists, 125 (1939) (*c*) Melville and Whyte, *ibid* , 119 (*d*) Weiss, *ibid* , 135

[5] Dainton, *Nature*, **160**, 268 (1947).

[6] (*a*) Cross, Bevan and Heiberg, *Ber* , **33**, 2015 (1900) (*b*) Stein and Weiss, *Nature*, **161**, 650 (1948) (*c*) Loebl, Stein and Weiss, *J Chem Soc* , 2074 (1949) (*d*) Merz and Waters, *ibid* , 2474 (1949)

[7] (*a*) Stein and Weiss *J Chem Soc* , 3245, 3254 (1949) (*b*) Loebl, Stein and Weiss, *ibid* , 2704 (1950) (*c*) Stein and Weiss (to be published) (*d*) Loebl, Stein and Weiss, *J Chem Soc* (in the press) (*e*) Day and Stein, *Nature*, **164**, 671 (1949)

[8] Weiss, *Nature*, **153** 748 (1944) , **157**, 584 (1946) , *Trans Farad Soc* , **43**, 314 (1947) , *Brit J Radiology*, Supp 1, 56 (1947)

[9] (*a*) Carter and Weiss, *Proc Roy Soc* , A, **174**, 351 (1940). (*b*) Weiss and Porret, *Nature*, **139**, 1019 (1937)

[10] Unpublished experiments of T Rigg

[11] (*a*) Walker and Weiss, *Trans Farad Soc* , **31**, 1011 (1935) (*b*) Huckel, *FIAT* Reports, Theoretical Organic Chemistry

[12] Williams, "Detoxication Mechanisms" (1947)

[13] For example, Dakin, *J Biol Chem* , **4**, 235 (1908)

[14] Wheland, *J Amer Chem Soc* , **64**, 900 (1942)

[15] Smith and Williams, *Biochem J.*, **46**, 243 (1950), and references given there

[16] Lederer, *J Chem Soc* , 2115 (1949).

[17] Cook, *J Chem Soc* , 1210 (1950) cf Boyland, Biochem Soc Sympos No 5, 40 (1950)

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# CLASSIFICATION, TRANSMISSION AND DETECTION OF ODOURS

A SYMPOSIUM on olfaction provided the main item of interest at a special general meeting of the Society of Cosmetic Chemists, held in the main hall of the Chelsea Polytechnic, Manresa Road, London, S W 3, on the evening of October 20

The subject was introduced by Dr William McCartney, of the Iodine Educational Bureau Speaking on "The Mysteries of Olfaction", Dr McCartney referred at some length and in very interesting detail to the literary and historical background of the subject, which as a basis for study certainly dates back to the ancients' preoccupation with incense and was specifically discussed by Theophrastus in his essay on odours Throughout the Middle Ages interest in olfaction was sustained and later assumed considerable importance in the writings of Montaigne and of Robert Boyle, who not only enunciated the celebrated law that bears his name and isolated methyl alcohol and acetone, but also apparently detected the odour of musk emanating from a decomposed heap of manure

Passing in brief review Hippolyte Cloquet's "Osphrésiologie" (1815 and 1921), Dr McCartney referred successively to the works of Saveliev, Zwaardemaker, Henning, Heyninx, Parker, Régismanset, Von Skramlik and others, and then to the more recent contributions to the subject made by Kenneth, Moncrieff, Sagarin, McCord, Witheridge, Le Magnen, Duncan and Cheesman Reference was also made to specialized works dealing with the sense of smell in animals, culminating in recent years with the valuable paper published by Walter. Olfactory perception among primitive peoples, the blind, and specialists such as tea-tasters and wine-tasters, represented a further approach.

Reference was doubtless intended to the investigations of Duncan and Cheesman in the observation that "in the domain of psycho-physiology, an up-to-date examination of the application of the Weber–Fechner law to the sense of smell seems desirable", in that the technique of the two workers mentioned is based on the type of statistical approach directly derived from that law, which may be briefly set down in the following terms "sensation is proportional to the logarithm of the stimulus, it being necessary to increase the stimulus geometrically in order to increase the sensation arithmetically"[1]

The difficulties confronting the would-be measurer of odour intensities and the scientific investigator of odour qualities were mentioned by Dr McCartney, who made no attempt to belittle them but nevertheless stopped short of the somewhat complacent references of Parry and Sagarin to what the latter has termed "the inherent invalidity of all systems of odour classification"

Dr McCartney considered that vibratory or wave theories of odour transmission have "overwhelming evidence against them" In regard to the various theories held by Beck and Miles, Cheesman and Duncan, Duranton, Guillot, Le Magnen, McCord and Witheridge, Moncrieff and others, he felt it impossible that "all these theories, which are to some extent mutually exclusive, can stand the test of time" "In any case," he concluded, "the modern theories and the experimental results on which they are based provide ample material for much fruitful discussion No scientific subject involves mysteries more profound than those of olfaction And certainly no subject is more fascinating and absorbing "

The next speaker, Dr G H Cheesman, confined most of his remarks to a description of the type of work now being carried out on odour classification at the University of Reading After referring to the more obvious difficulties of devising a reliably objective, quantitative approach to the inherently subjective field of olfaction, he went on to emphasize the comparatively straightforward character of 'threshold' measurements, which can not only be determined with the minimum subjective interference, but are also susceptible to the psychological technique of factor analysis[2]

Dr D R Duncan, a former collaborator in this work with Dr Cheesman, and the co-inventor with him of an improvement on the conventional Fair–Wells osmoscope, then described in some detail the main features of the 'odour fatigue' method whereby threshold values are determined Dr Duncan had previously read a paper entitled "The Perception and Measurement of Odour" before the British Esperanto Scientific Association[3]

A somewhat radical departure from the domain of determining threshold values was represented by the views of the next speaker, Dr R R Matalon, of the Department of Colloid Science, University of Cambridge Dr Matalon harked back to the work of Prof Henri Devaux, which had been briefly referred to in the introductory talk by Dr McCartney Devaux's experiments showed the phenomenon of odour transmission in visible form, as a surface-active effect on a bath of mercury covered with talc, the talc-dusted surface showing characteristic disturbance when subjected to the proximity of rose petals and other odorants[4] Dr Matalon went on to connect this fundamental work with the probable action of odorants on the cells or 'receptors' of the olfactory nerve system It seemed to him that further basic research on these lines is an essential prerequisite to the objective study of odours and any acceptable attempt at scientific classification

The final statement submitted to the symposium was a written contribution by Dr J H Kenneth, of Edinburgh, whose "Osmics The Science of Smell" was published in its complete form in 1924

The discussion started off somewhat slowly, but soon assumed a more interesting character—elucidation being not unmixed with critical comment and the statement of controversial opinions Some speakers supported, for example, the vibrational theory of odour transmission, while others appeared even to doubt the validity of what is perhaps rather ambiguously described as 'odour fatigue' The general feeling seemed to be in favour, on one hand, of the continuance of such work as is currently being undertaken by the University of Reading and, on the other, of devising a new type of approach to the subject that would logically continue the line of experimentation first indicated by Devaux Among those who joined in the discussion were Mr Jack Pickthall, Mr E S Maurer, Mr D W A Waite, Dr A W Middleton, Mr Frank Atkins, Mr James Bather and the Society's chairman, Mr F V Wells

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[1] See R W Moncrieff's "The Chemical Senses", pp 53–55

[2] See *Soap, Perfumery and Cosmetics*, 697 (July 1949)

[3] See *Nature*, March 11, p 394

[4] See R W Moncrieff's "The Chemistry of Perfumery Materials" p 279

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# RHEOLOGY AND THE CONSTITUTION OF MATERIALS

## ANNUAL CONFERENCE OF THE BRITISH SOCIETY OF RHEOLOGY

THE annual conference of the British Society of Rheology was held at St. Patrick's Hall, University of Reading, during September 28–30. The general title of the conference was "Rheology and the Constitution of Materials", and the papers on this subject stimulated discussions ranging over a very wide range of materials from metals to polymer solutions. At the annual general meeting of the Society, the change of name from the British Rheologists' Club to the British Society of Rheology was sanctioned, a change which reflects the important part which the Society is playing both as a link between men of science from different fields of work in Great Britain and as a prime mover in the formation of the International Union of Rheology The officers for 1950–51 are *President*, Dr G W Scott Blair, *Honorary Secretary*, Dr E W J. Mardles, *Honorary Treasurer*, Dr J G Oldroyd; *Honorary Editor*, Dr V W G Harrison

The presidential address, given on September 28 by Dr G W Scott Blair, was on "The Rheology of Uterine Cervical Secretions" Dr Scott Blair outlined the work which he and his colleagues have done on the relation of the properties of these secretions to the time of œstrus and the course of pregnancy for cows, and also similar studies made in conjunction with Mr A F Clift for women An emptying and filling capillary micro-viscometer was designed for this work which enabled measurements to be made with only 0 06 ml of secretion The original instrument, while giving very satisfactory results, was very tedious to use, and a new instrument giving automatic methods will shortly be brought into use A small-scale rotational viscometer was also described, it has been found that the shear in this instrument destroys the rheological properties most nearly related to the changes in hormone condition of the animals

The presidential address was followed by a paper by L Grunberg and Dr A H Nissan on "Viscosity, Constitution and Structure", with A G Ward in the chair Mr Grunberg outlined the history of the formula $\eta = A \exp(B/T)$ and its many variants. After considering the classification of liquids into "normal or dispersion liquids", "polar associated liquids", "ionic liquids" and "metallic liquids", the main part of the paper was concerned with the "normal liquids". In comparing two liquids, the need for choosing suitable conditions in each case was emphasized, and the choice of temperatures at which the vapour pressures are equal was justified on the basis of theoretical arguments A simpler method involves the comparison of viscosities at equal $T/T_B$, where $T$ is the temperature for the viscosity measurement and $T_B$ is the boiling point under atmospheric pressure The results of the application of this method to hydrocarbons and their halogen derivatives were given together with conclusions derived from the study of $E_{\text{visc}}/M$ $(=RB/M)$, where $M$ is the molecular weight The relation of the heat of mixing to viscosity data for regular solutions was also given A short contribution was made to the discussion by Dr. A Nisbet, outlining the theory of viscosity developed by Born and Green

The opening session on September 29 consisted of a paper by W G Harland and W A Richardson on "Intrinsic Viscosity", J G Oldroyd being in the chair Mr Richardson showed how important an exact statement of the procedure followed can be in determining the intrinsic viscosity of solutions. He reviewed the many equations which have been developed to express the concentration dependence of the viscosity of polymer solutions, and also the terminology which has been suggested by different authors Mr Richardson expressed the firm opinion that it is better to ensure that the terms used—specific viscosity, intrinsic viscosity, reduced viscosity, etc — should be those with the greatest chance of widespread adoption, rather than that an attempt should be made to impose a logical and rational new set of terms Discussion following the paper showed general agreement with Mr Richardson's views

The paper by Dr F R Eirich (Brooklyn) on "Flow Birefringence. Some Results on Concentrated Polymer Solutions" was, in Dr Eirich's absence, read by Dr E W J Mardles A H Nissan was in the chair The relation of the intrinsic viscosity, sedimentation constant, translational diffusion constant and rotatory diffusion constant to molecular size, shape and molecular weight were first discussed The need for two measurements of this type to enable molecular constants to be calculated was emphasized Particular attention was given to the combination of the intrinsic viscosity with the rotatory diffusion constant, the latter being determined from the extinction angle, and to the relation of the results to molecular models for chain molecules

In the afternoon a visit was paid to the National Institute for Research in Dairying, Shinfield, Reading Dr. Scott Blair and his collaborators showed exhibits illustrating work on the rheology of cheese and butter, including the use of factorial analysis, and also the apparatus used for cervical secretions A film was shown of the scientific study of cheese testing, and a general tour of the Institute was arranged.

The evening session was devoted to papers by Dr L R G Treloar on "The Structure and Properties of Rubber", and by H H Macey on "The Flow of Clay Systems". Dr V W G Harrison was in the chair. Dr Treloar reviewed the theory of rubber-like elasticity and the crystallization of rubber, and illustrated his paper by convincing demonstrations of the various effects Mr Macey developed a quantitative theory of the plasticity of clay–water systems based on the forces of interaction between the clay particles The interaction can be represented by repulsive forces which are compensated at the boundary by surface tension The theory is able to give both a qualitative and quantitative interpretation of much of the experimental results for plastic clay Considerable discussion followed Mr. Macey's paper concerning the nature of the water film between the clay particles, and whether any structure is imparted to the water by the forces from the clay particle surface over distances of more than a few molecular diameters

The morning session of September 30 was devoted to the rheology of metals, with Prof M Reiner (Haifa Technical College) in the chair The first paper, "The Role of Structural Discontinuities in Crystal Plasticity", was given by K E Puttick and M W Thring Emphasis was placed on the importance of the rate of strain in measurements of yield of metal The theories explaining yield in terms of dislocations were described and related to the experimental results P Feltham in his paper, "Trends in the Rheology of Metals at High Temperatures", stressed the dangers of approaching so complex a field from a narrow or mechanistic point of view This was shown to lead to a divorce between 'pure' physical studies, suited to the academic worker, and 'applied' metallurgical studies which are left to the works laboratory These considerations were illustrated by the inelastic behaviour of metals at high temperatures

Alan G. Ward

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# THE AGRICULTURAL AND HORTICULTURAL RESEARCH STATION, LONG ASHTON

## ANNUAL REPORT FOR 1948

THE University of Bristol Agricultural and Horticultural Research Station, at Long Ashton, maintains its tradition of balanced practical research into problems of fruit growing and fruit products In its annual report for 1948*, Dr L C Luckwill reports that alpha-naphthalene acetic acid (5 p p m ), 2 4 dichlorophenoxy-acetic acid (1 p p m ) and indolyl-acetic acid (5 p p m ) all reduced fruit-set without causing damage to the foliage These substances were applied as sprays shortly after the time of full blossom, and are designed to control superabundant fruiting, with subsequent abscission and loss of too much fruit Dr Luckwill has also studied the ecology of orchard cover crops, finding that rye-grass and clover mixtures tend to be replaced by creeping bent The last-mentioned grass, however, is itself good for the purpose. C Bould, J A H Tolhurst and R M Jarrett have investigated the effect of cover crops on fruit-tree nutrition, finding they had little effect on yield and girth increase, but lowered the nitrogen content of foliage, as compared with clean cultivation C Bould and J Tolhurst bring further evidence that magnesium deficiency of fruit trees can be cured effectively by three or four foliage sprays of 2 per cent magnesium sulphate

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* University of Bristol Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1948 Pp 250 (Bristol The University, 1949 )

Prof T Wallace, director of Long Ashton Research Station, leads a group of workers on problems of plant nutrition, the present papers dealing mainly with the effects of farmyard manure on potatoes (with E Catlow) E J Hewitt has an interesting paper on the resolution of factors in soil acidity, discussing the relative effects of aluminium and manganese toxicities The same worker reports on iron deficiency and (with E W Jones) on molybdenum deficiency.

Dithiocarbamates, organic mercurials, substituted quinols and glyoxalidine derivatives have been suggested as alternatives to lime sulphur spray for the control of plant diseases These are described in a short paper by R W Marsh, glyoxalidine seemed to give the most promising results The proper healing of wounds is an important factor in plant pathology S H Crowdy has studied the effect of organic chemicals on the process, and makes the suggestion that the inclusion of plant growth substance in wound dressings may have advantages Some promising results on the control of brown rot of fruits by spraying with phenyl mercury chloride are reported by R J. W Byrde The insecticide DDT has attained such popularity that it is natural to investigate the toxic properties of its analogues This is being done by S H Bennett, H Martin, A Stringer and D Woodcock, who issue a progress report

A former director of the Station, Prof B T P Barker, contributes a paper on 'cider sickness', finding at least three different bacteria which can cause it S W Challinor and L F Burroughs contribute two papers dealing with the role of nitrogen in fermentation, as part of a fundamental study of the chemistry of cider As another part of the inquiry into cider-making processes, Margaret E Kieser, A Pollard and Audrey M Stone report on the pectose activity of some apple varieties The browning of processed pears can be avoided by quick processing, to attain temperatures which inactivate the enzymes (Dilys James and Alice Crang)

The research at Long Ashton is thus a welcome blend of fundamental and applied studies, and the report itself is informative It is now edited by G T Spinks, who is to be congratulated on the maintenance of its high standard of production

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# HIGH-TEMPERATURE ADIABATIC CALORIMETRIC MEASUREMENTS OF THE TRANSITION METALS

THE advantage of adiabatic calorimetry is that it allows specific heats to be measured directly over small temperature intervals and thus to obtain details of the variation of specific heat with temperature Until recently, however, because of the difficulties of adequate thermal insulation at high temperatures, accurate work with adiabatic calorimeters was not possible at temperatures above 700° C Further, the atomic heats of metals in the transition group, chromium to nickel, are of considerable theoretical interest, but reliable data at high temperatures exist for iron and nickel only Two papers which appeared in the January issue of the *Canadian Journal of Research*[1] are therefore of considerable interest In the first, a description is given by L D Armstrong of the construction of a new high-temperature adiabatic calorimeter which, by making use of special techniques developed previously for the measurement of thermal conductivities at high temperatures[2], can be used for making reliable determinations of specific heats up to 800° C

The specimen, either a machined cone of solid metal or in the form of a powder or loose pieces packed firmly together, fits into a copper container, and the specimen and container are electrically heated The surrounding copper radiation jacket, which is maintained at a temperature as close as possible to that of the container, is supported inside an electrical furnace which can be evacuated or filled with an inert gas Temperatures are measured by thermocouples The heat capacity of the empty calorimeter is determined by two series of measurements one with the calorimeter empty, and the other with the calorimeter filled with the standard material, aluminium oxide in the form of synthetic sapphire, the specific heat of which is known accurately from the work of D C Ginnings and R J Corruccini[3] It is claimed that specific heat values derived from a smoothed specific heat/temperature curve obtained from measurements made with the adiabatic calorimeter are correct to within 1 per cent

In the second paper, measurements of the specific heats of chromium, manganese and cobalt made with the adiabatic calorimeter are described by L D Armstrong and H Grayson-Smith The chromium used was in the form of electrolytic flakes and was 99 9 per cent pure The atomic heat of chromium is regular from 0 to 800° C, increasing steadily above 100° C to values considerably in excess of the classical value $3R$ For manganese, in the form of electrolytic nodules and of 99 99 per cent purity but slightly discoloured by surface oxidation, the measurements show that the atomic heat is quite regular from 0 to 700° C with values considerably greater than $3R$ At 717° C the transition from the $\alpha$- to the $\beta$-phase takes place sharply with a latent heat of 450 cal/mol Supercooling occurs on cooling from the $\beta$- to the $\alpha$-phase Except for the interval 447–478° C, where cobalt changes its structure on heating from hexagonal close-packed to face-centred cubic, the atomic heat increases regularly The heat of transition was estimated to be 60 cal/mol approximately

The experimental values are used for a theoretical discussion of the atomic heats of the transition metals, all of which are considerably greater than $3R$ at high temperatures The excess specific heats of the ferromagnetic substances cobalt and nickel can be accounted for by the ferromagnetism and the conduction electrons For chromium and manganese, after allowance is made for the conduction electrons, there is still a large residual excess specific heat indicating some unknown source of internal energy, attributed tentatively to antiferromagnetism It is suggested that the two metals may have antiferromagnetic Curie points at temperatures above 800° C, but there is little evidence at present to support such a proposal

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[1] *Canadian J Res*, **28A**, 44 and 51 (1950)

[2] *Canadian J Res*, **25A**, 357 (1947)

[3] *J Res Nat Bur Standards*, **38**, 583 (1947)

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents No notice is taken of anonymous communications*

## The Helium-3 Problem of the Atmosphere

IN a communication in the *Zeitschrift für Naturforschung* of August 2, 1950, we have reported our attempts to prove the presence of tritium ($H_3$) in the atmosphere The free atmospheric hydrogen, which is found in the air in a concentration of $5 \times 10^{-7}$, was burned with copper oxide out of the helium–neon fraction of an air-liquefaction plant The water was electrolysed down to one-fortieth of its volume in order to enrich the tritium twenty times The tritium-containing hydrogen of the enriched water was used to make ethane, the activity of which could easily be examined According to our measurements, about one mole of elementary tritium is present in the whole dry atmosphere of the earth, or one atom of tritium in 10 cm$^3$ of air Evidently this tritium has been produced by nuclear fission in the upper layers of the atmosphere, and did not take part in the atmospheric water circulation, but has remained elementary hydrogen

Now it is possible to compare the amount of helium-3 found in the earth's atmosphere with that produced in the course of the earth's history by tritium, which has a half-life of 12 years, breaking down to helium-3 For this purpose it is necessary to have a precise total balance for the tritium We have, indeed, determined the amount of tritium in the free hydrogen of dry air, but it is to be expected that a much higher amount of tritium will take part in the water circulation of the atmosphere On one hand this amount can be estimated from kinetic relations and the distribution of the cosmic radiation intensity, on the other hand, the measurements of Willard F Libby (Chicago) and A V Grosse (Temple University), published in *Time* of September 25, 1950, give the concentration of tritium in rain water as $10^{-18}$, from which follows the interesting result that there is an enrichment of about 10,000 in atmospheric hydrogen compared with rain water

If the intensity of the cosmic radiation has always been the same as now, and taking 3 6 $\times 10^9$ years for the age of the earth, there should be $2 \times 10^7$ atoms of helium-3 in 1 cm$^3$ of air under normal conditions, if only the tritium in the free hydrogen of the dry atmosphere is taken into account. In fact, there are 1 5 $\times 10^8$ atoms of helium-3 in 1 cm$^3$ of air It is obvious that this estimated concentration of helium-3 is only one-eighth of that really found

However, the cosmic radiation may have produced primarily as much helium-3 as tritium, furthermore, a large part of the tritium has certainly come into the water circulation With an assumed mean annual rainfall of 18 cm, averaged over the whole earth, and a concentration of tritium of $10^{-18}$, as measured by Libby and Grosse, the estimated figure for the concentration of helium-3 should rise to about $5 \times 10^9$ atoms/cm$^3$ In this case most of the helium-3 must have left the earth

By measuring the concentration of tritium in several samples of $C_2D_6$ prepared from heavy water, we hope to get a fairly accurate value for the tritium content of the whole earth, which would form a necessary base for discussing the problem of the loss of helium-3 from the atmosphere

PAUL HARTECK
VOLKERT FALTINGS

Institut für physikalische Chemie,
Universität, Hamburg
Sept 30

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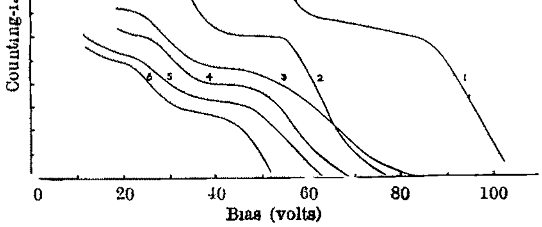
## Alpha-Particle Scintillations in Organic Compounds

THE papers[1–7] previously published on organic luminescent materials do not enable a direct and reliable comparison of their conversion efficiencies (conversion of incident radiation energy into light energy) to be made This is so because different types of photomultipliers have been used and not all the compounds have been investigated with similar radiation Further, the results reported are not consistent Most of the materials previously used have been re-investigated in this laboratory under the same conditions in each case and their efficiencies as scintillation counters assessed The effective use of a fluorescent material depends on the spectral response of the photomultiplier and on the wavelength of the light emitted when a scintillation takes place The results presented are therefore of additional interest, as *RCA* 931 type photomultipliers were used to obtain the major part of the information available in the literature, whereas the results given here were obtained with an *EMI* 5311 photomultiplier which has a different response In addition, materials not so far reported on have been investigated

Results obtained with α-particles seem to provide the most satisfactory basis of comparison Integral bias curves have been obtained using α-particles (6 04 and 8 72 MeV) from thorium C and C′ This procedure has the further advantage that thin crystals with an area of one or two square millimetres are adequate The crystals chosen were as thin as possible, consistent with stopping all the α-particles In this way, the β- and γ-ray background was kept to a minimum Results were considered reliable only if the integral bias curve showed two α-particle groups indicating complete stoppage of the lower group, which could therefore be used for comparing the performances of the compounds

To ensure that measurements of this type shall be reliable, it is necessary to pay particular attention to the purity of the samples[2] As only a few small crystals were required, it was possible to obtain a good deal of purification by recrystallization from



Integral bias curves for organic phosphorus using α-particles from thorium C and C′ (1) anthracene, (2) naphthalene, (3) chrysene, (4) 1 4 diphenyl butadiene, (5) 2 2′ dinaphthyl, (6) stilbene organic solvents Repeated recrystallization enabled the purity to be checked by observing the pulse-heights obtained with crystals from successive samples, but, of course, one cannot be certain that all impurities have been eliminated

The bias value, corresponding to the lower α-particle group obtained from an integral bias curve for each substance, has been used to sort the materials into the three groups shown in the accompanying table The curves shown are integral bias curves for the substances tabulated in groups 1 and 2 The relative heights of these curves have no significance as each curve was obtained with a different counting-rate

Relative Efficiencies of Organic Phosphors

| ~ 50 volts | ~ 30 volts | < 20 volts |
|---|---|---|
| Anthracene | Stilbene<br>2 2′ Dinaphthyl*<br><br>Chrysene*<br>1 4 Diphenyl butadiene*<br><br>Naphthalene<br>+~1 per cent anthracene | Pyrene<br>Phenanthrene<br>Acenaphthene<br>Fluorene<br>Dibenzyl<br>Anthranilic acid<br>Fluoranthene*<br>1 2 Benzanthracene<br>Diphenyl<br>Triphenyl methane |

* Not previously reported

The following points are of interest

(1) When scintillations are caused by thorium-C α-particles, the pulse-height obtained from anthracene is about twice that obtained using the materials in group 2 The ratio of 2 . 1 for the pulse-heights from anthracene and stilbene is in agreement with the results of Harding *et al* [7]

(2) The five materials in group 2 are about equally effective The three materials not previously reported may merit further investigation to obtain information on the effect of rigorous purification, decay time, ease of crystallization, etc

(3) None of the substances in Group 3 is effective In particular dibenzyl[4], which has been reported as a useful phosphor, has a very poor performance when it is used with the *EMI* photomultiplier Koski and Thomas[5] have also found that this substance is poor when used with *RCA* 931*A* type photomultipliers

(4) All the compounds previously reported are included in the table with the exception of phenyl benzal glyoxalidine[1], terphenyl[4] and diphenylacetylene[5,6] We have been unable to obtain these substances The first has been reported as poor, and its omission is not serious Diphenylacetylene has been reported as good[5,6], and its omission is unfortunate.

We wish to thank Messrs Petrocarbon, Ltd., for supplying many of the chemicals used in this work

B Collinge
E J Robbins

Nuclear Physics Research Laboratories,
Liverpool
Aug 30

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## Gallium Anisotropy and Crystal Structure

An earlier communication[1] directed attention to the ease with which single crystals of gallium could be produced and to the highly anisotropic properties of the specimens so obtained The room temperature electrical conductivities as determined for the three mutually perpendicular axial directions were in the ratios of 1 3 2 7, and the corresponding expansion coefficients were in the ratios of 1 0 7 1 9 At that time, the axial directions had been related to the geometrical form and positioning of the seed crystal used when growing the specimens The seed crystal had the symmetrical pyramidal form which is characteristic of crystals formed from liquid gallium when cooled to some 10° C below the normal melting point The axial direction giving the low conductivity had been found to coincide with the geometrical axis passing through the well-defined crystal point, while the other two axial directions coincided with the diagonals of the approximately square base of the pyramid

An X-ray examination of the gallium seed crystal has now been made by Mr E A Calnan, of the Metallurgy Division of this Laboratory Back reflexion Laue patterns produced with the beam directed along the pyramid axis of the specimen showed elements of four-fold symmetry, confirming that the crystallographic pseudo-four-fold axis was within about 1° of the geometrical axis of the crystal This indicates that the *c*-axis is parallel to the pyramid axis From further consideration of the angles between the plane normals corresponding to the Laue reflexions and the systematic missing spectra, it was possible to identify the *a*- and *b*-axes and to show that their directions coincided with the diagonals of the pyramid base, and thus with the other two conductivity axes

From subsequent measurements of the electrical conductivity of single-crystal rods grown from this crystal in the identified *a* and *b* axial directions, it has been found that the good conducting direction coincides with that of the *b*-axis Thus the axial directions designated as 1, 2 and 3 in Table 1 of the earlier communication[1] are now identified as conforming to the *c*-, *a*- and *b*-axes of the gallium crystallographic structure Thus, it is for the *c* *a* *b* axes that the conductivities are in the ratio of 1 3 2 7, and the expansion coefficients in the ratio of 1 0 7 1 9

According to Bradley[2], eight atoms of gallium occupy an orthorhombic cell The dimensions, obtained by converting from the kX-units originally used, are $a = 4\ 5258$ A, $b = 4\ 5198$ A, $c = 7\ 6602$ A The space-group is $V_h^{18}$ and the atomic co-ordinates are $(m, 0, p)$ $(m + \frac{1}{2}, \frac{1}{2}, \bar{p})$ $(\bar{m} + \frac{1}{2}, \frac{1}{2}, p)$ $(\bar{m}, 0, \bar{p})$ $(m, \frac{1}{2}, p + \frac{1}{2})$ $(m + \frac{1}{2}, 0, \bar{p} + \frac{1}{2})$ $(\bar{m} + \frac{1}{2}, 0, p + \frac{1}{2})$ $(\bar{m}, \frac{1}{2}, \bar{p} + \frac{1}{2})$, where $m = 0\ 0785 \pm 0\ 0005$ and $p = 0\ 1525 \pm 0\ 0005$

It will be seen that the lowest conductivity occurs for the direction having the greatest lattice spacing, but it seems probable that the large (2 2-fold) increase in conductivity between the *a*- and *b*-directions is due to some other cause than a decrease of about 6 parts in 4,500 in the lattice spacing

There may be some significance in Laves's[3] suggestion that the closest pairs of atoms form $Ga_2$ molecules This would reduce the structure to four such molecules per cell, lying symmetrically in the *a*–*c* plane at angles of ± 17° (approximately) to the *c*-axis, the spacing of these molecular planes being *b*/2 On this basis, the good conductivity axis would be normal to the molecular plane, while the intermediate and low conductivity axes would be in this plane with the molecules aligned at angles of approximately ± 73° and ± 17° to the respective conductivity axes

The work, which is being continued, forms part of the research programme of the National Physical Laboratory and the above account is published by permission of the Director of the Laboratory

R W Powell

Physics Division,
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Teddington, Middlesex
July 17

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[1] Powell, R W, *Nature*, 164, 153 (1949)

[2] Bradley, A J, *Z Kristall*, 91, 302 (1935)

[3] Laves, F, *Z Kristall*, 84, 293 (1933)

## Combustion of Fuel Droplets

We were very much interested in Mr G A E Godsave's letter[1] on the combustion of fuel droplets, for we also have been studying the same subject

We have measured the time of burning of droplets suspended at the end of a silica filament or metallic wire by a photographic method in still air The time of burning, $T$, is found to be directly proportional to the square of the initial diameter of the droplet, $d_0$, over the range of drop-size investigated (approximately 1 3–0 3 mm ) This is exactly the same as saying that the burning-rate is directly proportional to the diameter, $d$, of the drop at any instant, which is the result obtained in Godsave's experiment

We can compare the life of droplets of various kinds of fuel by means of the relation $T/d_0^2$ (which we call the specific burning-time) When using the platinum wire in our experiment, it was found that the burning-time was considerably shortened This may be due to catalytic combustion

We propose to give a detailed account of our work in the *Transactions of the Society of Mechanical Engineers, Japan.*

Seiichiro Kumagai
Hiroshi Isoda

Department of Mechanical Engineering,
Faculty of Engineering,
University, Tokyo
Aug 25

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[1] *Nature*, 164, 708 (1949)

It is of interest to find that Drs Kumagai and Isoda's results are in agreement with the earlier measurements at the National Gas Turbine Establishment The constant $T/d_0^2$ they refer to as the specific burning-time is the inverse of a quantity referred to in the work at the National Gas Turbine Establishment as the evaporation constant $\lambda$ In the case of liquid fuel drops, the latter concept is perhaps of more general significance, as it can be applied to evaporation under both non-burning and burning conditions In the low-temperature case the evaporation-rate is determined by diffusion processes, and in the high-temperature case the evaporation-rate is determined by heat transfer processes In both cases experiments have shown that the mass evaporation-rate is proportional to the first power of the radius of the drop Hence in both cases $T/d_0^2$ is constant, and may be conveniently referred to in the general case as the specific lifetime of the drop

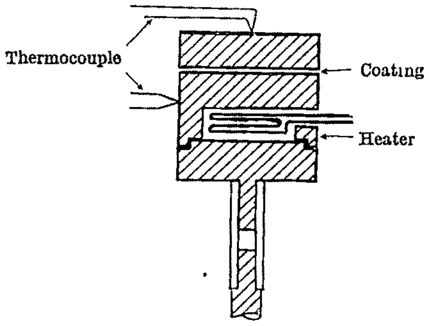
Without further details, it would appear that the suggestion of Kumagai and Isoda that catalytic effects are of importance in the case of suspension on a platinum wire is unlikely The investigations at the National Gas Turbine Establishment of the mechanism of the combustion of single drops of liquid fuel (in which all the combustion reactions occur in the vapour phase) have emphasized that the heat transfer to the drop is the dominant factor determining its life This being so, a platinum wire suspension (which presumably through geometric necessity would pass through the flame surrounding the drop) would increase the heat transfer of the drop, and hence would decrease its life as compared to the case of suspension on a silica filament

G A E Godsave

National Gas Turbine Establishment,
Ministry of Supply
Nov 7

## Thermal Conductivity of Barium Strontium Oxide

Only two values of the thermal conductivity of barium strontium oxide have been published 0 00034 cal deg $^{-1}$ cm $^{-1}$ sec $^{-1}$ obtained by Clausing and Ludwig[1], and 0 000123–0 0013 cal deg $^{-1}$ cm $^{-1}$ sec $^{-1}$ by Patai and Tomaschek[2]. Hamaker[3] pointed out, however, that the methods employed by these workers were open to objections, since they depended on optical pyrometric measurements made on coated cathodes, and no allowance was made for the semi-transparency of the coating



A method based on Lees's disk has been developed to overcome these objections The assembly, shown in the accompanying diagram, consisted of three nickel disks, 1 in diameter and ¼, ½, and ¼ in wide respectively The centre ½-in disk contained an alundum-covered, molybdenum-strip heater closed in by the lower disk Barium strontium carbonate was sprayed on the top of the centre piece and the top disk pressed on to it Thermocouples welded to the nickel were used for measuring the temperature-drop across the coating, and leads permitted the passage of current through it for activation purposes The whole block, supported on a ceramic tube, was erected in a continuously pumped demountable bulb, and the carbonate decomposed by heating the block to 950° C by a high-frequency coil After cooling, the heater was switched on, and thermocouple readings taken when a steady state had been reached Since coatings of the order 50–200 $\mu$ were used, the heat losses at the edges could be neglected and thus the heat conducted through the coating was equated with the heat lost by the top disk. The latter was computed from total emittance values measured as a subsidiary experiment on similar nickel made up into tubes.

If the temperatures of the centre and top disks are $T_1$ and $T_2$ respectively, then

$$A_1 l_T \sigma T_2^n = A_2 k(T_1 - T_2)/d,$$

where $A_1$ is surface area of top disk, $A_2$ is area of coating, $d$ is thickness of coating; $k$ is thermal conductivity of coating, $l_T$ is total emittance of the nickel, $\sigma$ is Stefan's radiation constant, $n$ is a constant ($\sim 4$). $l_T$ and $n$ were found by the subsidiary experiment.

Preliminary results have shown values of 1–5 × $10^{-6}$ cal deg$^{-1}$ cm$^{-1}$ sec$^{-1}$ at 1,000° K., increasing slightly with temperature.

The results appear independent of the compression of the original carbonate, and of the state of activation of the oxide.

The low order of these values agrees with those obtained by Aberdeen and Laby[4] for other powders in vacuum, and fits in with the theory of heat conduction in powders proposed by Smoluchowski[5]. Further investigations are in progress.

I wish to thank Dr. J. A. M. van Moll and the directors of Philips Electrical, Ltd., for permission to publish this communication.

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[1] Clausing, P., and Ludwig, J. B., *Physica*, 13, 193 (1933).
[2] Patai, E., and Tomaschek, Z., *Koll. Z.*, 74, 253 (1936).
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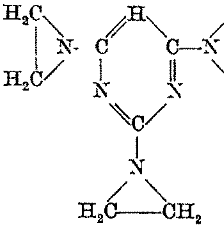
[5] Smoluchowski, M. M., *Bull. Intern. Acad. Sci. Cracovie*, 5A, 129 (1910); 8A, 548 (1911).

## Chromosome Alteration and Tumour Inhibition by Nitrogen Mustards: the Hypothesis of Cross-linking Alkylation

THE hypothesis has been advanced that the 'radiomimetic' activity of nitrogen mustards depends on the presence of two reactive groups in the mustard molecule. It has been further suggested that chromosome bridging and breakage, which result from treatment of proliferating cells with mustards, are a direct consequence of interchromatid cross-linkage by single polyalkylating molecules[1,2]. Such a mechanism of chromosomal damage could be considered as a plausible explanation of the effective actions of nitrogen mustards and certain other polyfunctional molecules, such as polyethylenimines and diepoxides, against mammalian tumours. However, recent studies of a number of monofunctional compounds related in structure to nitrogen mustards and diepoxides raise some questions concerning the validity of these generalizations.

Structural alterations in chromosomes resembling those produced by polyfunctional nitrogen mustards can be readily obtained in proliferative cells treated with monofunctional compounds. In one set of experiments, root tips of *Allium cepa* were exposed to solutions of two agents with more than one reactive group per molecule, namely, methyl-*bis*(2-chlorethyl)-amine and 2,4,6-*tris*(ethylenimino)-*s*-triazine (I), they were also treated with various agents with but one alkylating ethylenimino group per molecule, for example, 2-ethylenimino-4,6-dimethoxy-*s*-triazine (II) and ethylenimine itself. The former two agents were used in concentrations of 1·0, 0·1 and 0·01 m*M*/litre. The last two agents were used in the same concentrations and at 10·0 m*M*/litre. Exposure was for one-half hour, after which the bulbs and roots were washed and returned to fresh tap-water. Feulgen squash preparations were made of roots fixed at intervals during four or five days after exposure.



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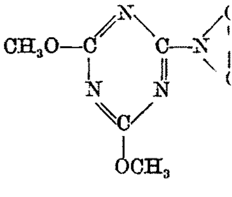
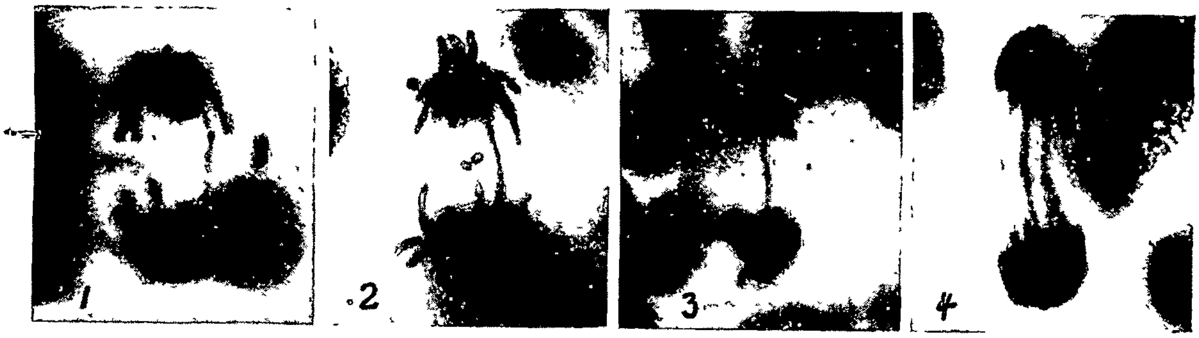


II

All agents caused chromosome breaks. After methyl-*bis*(2-chlorethyl)-amine, an initial period of mitotic inhibition was followed by the occurrence of mitotic figures showing anaphase bridges and chromosome fragments in highest frequency on the third and fourth days. Most abnormal anaphases were seen in roots treated with 0·1 and 0·01 m*M*/litre of this compound. After (I), abnormal anaphases were noted less frequently than after methyl-*bis*(2-chlorethyl)-amine, and the most effective concentrations were 1·0 and 0·1 m*M*/litre. The monoethylenimine agent (II) caused less mitotic inhibition than the two previous agents but apparently more chromosome breakage. All four concentrations were very effective. Ethylenimine in concentrations of 10·0–0·01 m*M*/litre caused chromosome breaks in considerable frequency, but it was not until the fifth day that they were much in evidence, because a prolonged mitotic inhibition had first to be overcome. Representative abnormal anaphases observed after treatment with these agents are illustrated in Figs. 1–4.

Tissue cultures of mouse embryonic skin and Crocker mouse sarcoma 180 were also used for demonstrating the effectiveness of monofunctional agents in causing structural chromosome changes. Glycidol (2,3-epoxy-1-propanol) and ethylenimine in fractional millimolar concentrations were found, two days after exposure, to elicit anaphasic bridges and chromosome fragments at levels higher than their low normal frequency in the cultured mouse cells.

The capacity of the above monofunctional derivatives to damage proliferating cells is not limited to effects which can be elicited solely *in vitro*. Indeed, compound (II), other monoethylenimine derivatives, and ethylenimine itself, when administered intraperitoneally to rats, have been found to disturb hæmatopoiesis and to give rise to pancytopænia in a manner resembling the well-known effects of mustards. Of great interest has been the observation that aberrant anaphases appear in the bone marrow of rats 72 hr. after administration of sublethal, though leucopænic, doses of (II) and other monoethylenimine derivatives. Myelocytes and metamyelocytes which exhibit the aberrant anaphases contain well-defined chromosome bridges and acentric fragments. In addition to its mustard-like effects in normal hæmatopoietic tissues, compound (II) has been shown to inhibit in mice the growth of transplanted



Cells at anaphase of mitosis from *Allium cepa* root-tip preparations Acetic-alcohol and Feulgen (× 1,455)

(1) Anaphase showing one chromosome bridge and two fragments, 92 hr after a half-hour exposure to 0 1 m*M*/litre 2,4,6-*tris*(ethylenimino)-*s*-triazine (2) Anaphase with one dicentric bridge and fragment, 23 hr after half-hour exposure to 0 1 m*M*/litre 2-ethylenimino-4,6-dimethoxy-*s*-triazine (3) Anaphase with bridge and small fragment, 72 hr after half-hour exposure to 0 1 m*M*/litre ethylenimine (4) Late anaphase with several bridges, 96 hr after half-hour exposure to 1 0 m*M*/litre ethylenimine, two very small fragments were noted near the bridges

sarcoma 180 and to cause a rapid fall to subnormal levels of the high leukocyte count characteristic of the advanced stage of leukæmia *Ak*4

It is clear that the monofunctional agents described above cannot elicit 'radiomimetic' effects in chromosomes and proliferating cells by a mechanism involving 'cross-linking' alkylation Nevertheless, these agents contain reactive groups similar to those present in polyethylenimines such as (I), diepoxides, and the ethylenimonium transformation products of nitrogen mustards The role of the ethylenimonium moieties in the biological actions of the nitrogen mustards is well known (see review, ref 3) The 'radiomimetic' effects of diepoxides have recently been described[2], and, in addition, mustard-like actions of polyethylenimines, such as (I), have been reported in normal[4] and tumour-bearing mammals[5-8]

It is recognized that the results reported here do not negate the possibility that the polyfunctional alkylating agents may effect 'radiomimetic' action through a cross-linkage of vital fibrous molecules Nevertheless, it appears more reasonable to consider the radiation-like activity of the compounds under discussion to be related to the possession of molecular configurations with similar chemical properties, namely, unstable 3-membered heterocyclic radicals We are not aware at the moment of any molecular class having the 'radiomimetic' activity of nitrogen mustards both *in vitro* and *in vivo*, which does not contain this configuration either in the parent compound or in some active transformation product Against this tentative generalization may be raised the reported failure to demonstrate ethylenimonium moieties as intermediates in the reactions of the 'radiomimetic' N,N-*bis*(2-chloroalkyl) arylamines[1] However, it should be noted that N-phenyl-ethylenimine has been prepared synthetically[9] Thus the existence of N-aryl ethylenimonium transformation products appears possible, although such derivatives of weakly basic aromatic amines might be expected to be unstable and difficult to detect[3].

We wish to acknowledge support of part of the work reported herein by grants from the National Cancer Institute, U S Public Health Service, from the American Cancer Society, from the Damon Runyon Memorial Fund, and from the Elsa U Pardee Fund We also wish to express our indebtedness to Dr M L Crossley, Dr. R P Parker, jun , and their associates in the American Cyanamid Co for generous supplies of the ethylenimine and ethylenepoxy derivatives used in the present work, and our appreciation to Dr J H Paden of the same Company for information concerning the synthesis of N-phenyl-ethylenimine

J J Biesele
F S Philips
J B Thiersch
J H Burchenal
Sonja M Buckley
C C Stock

Division of Experimental Chemotherapy,
Sloan–Kettering Institute for Cancer Research,
New York City
July 10

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In the foregoing communication, attention is directed to the ability of certain monofunctional alkylating agents to produce chromosome damage and inhibition of tumour growth. Similar cytological observations have been made in this Institute[1]

Thus, in addition to ethylene imine and ethylene oxide, analogues of the sulphur and nitrogen mustards, namely, ethyl 2-chlorethyl sulphide and 2-chloroethyl dimethylamine, are able to produce chromosome breakage in plant material However, as has been found in animal experiments by Philips[2], the effect is elicited only by concentrations some fifty times that required of bifunctional analogues Doses of the same order as used in the case of bifunctional compounds have proved to exert no measurable effect upon the growth-rate of the Walker carcinoma[3] Ethylene oxide has also been shown by Rapoport[4] and by Bird[5] to be mutagenic for *Drosophila*, and Rapoport has also established the mutagenic activity of ethylene imine[6] It is therefore apparent that, while monofunctional compounds do produce effects which are similar to those produced by the 'mustards', they are less effective in this respect than difunctional compounds of like chemical character

In the course of work by our colleague, G M Timmis, on other types of polyfunctional compound (which will shortly be published) it was found that 1 4-*bis*-methanesulphonoxybutane $CH_3 SO_2 O (CH_2)_4 O SO_2 CH_3$ inhibited the growth of sarcoma 180 and produced typical radiomimetic effects in the blood and bone-marrow, also one of us (A L ) has found that dimethyl sulphate produces chromosome breakage in plant material Now these compounds cannot form three-membered rings, but they can react by a carbonium ion mechanism, as also can epoxides, ethylene imines and the sulphur and nitrogen mustards The ability to produce carbonium ions is thus a more general feature of this group of radiomimetic agents than the ability to produce a compound containing an unstable three-membered ring system

This subject will be dealt with more fully in future publications

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## Identification of the Gene for Maltose Fermentation in *Saccharomyces Italicus*

IN 1949, Gilliland[1] established the fact that only one gene for maltose fermentation is present in *Saccharomyces Italicus* He crossed this species with *S Chevalieri*, which is unable to ferment maltose and is therefore of the recessive formula *mm*, and obtained a hybrid *Mm* All the 4-spored asci isolated from this interspecific hybrid yielded two fermenters to two non-fermenters of maltose

We have found[2,3] that *S cerevisiæ* (type Yeast Foam) contains three polymeric genes for maltose fermentation, $M_1$, $M_2$ and $M_3$ By crossing *S cerevisiæ* with the recessive *S Chevalieri*, we obtained a triple heterozygote, and we succeeded in isolating genotypes possessing $M_1$ alone, $M_2$ alone and $M_3$ alone In addition, we obtained through spontaneous mutation, as well as mutation induced by Rontgen rays, a fourth *M*-gene which we have called $M_4$ These four *M*-genes are inherited independently of one another

By spore-crossing *S Italicus* with $M_1$, $M_2$, $M_3$ and $M_4$ yeast types, we have now established that the *M*-gene in *S Italicus* is $M_1$ The crossing between an $M_1$-type and *S Italicus* yielded a hybrid from which eighty spores were isolated The subsequent eighty single-spore cultures all fermented maltose Extensive tetrad analyses were not possible with this material, since the hybrid, like *S Italicus*, produced almost exclusively 2-spored asci on gypsum

It was to be expected that each of the hybrids obtained by spore crossings between *S Italicus* and the $M_2$, $M_3$ and $M_4$ types would be doubly heterozygotic, $M_1m_1M_2m_2$, $M_1m_1M_3m_3$ and $M_1m_1M_4m_4$, respectively This proved to be the case, as is evident from the following segregation ratios, which likewise were obtained from 2-spored asci

| Crossing | Hybrid No | Segregation from the hybrids | |
|---|---|---|---|
| | | Maltose fermenters | Non-fermenters |
| *S Italicus* × $M_2$ | 145 | 22 = 62 9 per cent | 13 = 37 1 per cent |
| *S Italicus* × $M_3$ | 147 | 27 = 67 5 ,, | 13 = 32 5 ,, |
| *S Italicus* × $M_4$ | 149 | 26 = 74 3 ,, | 9 = 25 7 ,, |
| | | 75 | 35 |

Theoretically, a 2-gene segregation should give 75 per cent fermenters to 25 per cent non-fermenters, since we had previously demonstrated that there exists a cross-over value of approximately 50 per cent between each of the *M*-genes and its centromere Thus the 110 single-spore cultures from Hybrids 145, 147 and 149 should have yielded 82 5 fermenters and 27 5 non-fermenters The observed figures, 75 35, differ from the theoretically expected by 7 5, which is only 1 65 times the standard error (4 54)

No fundamental differences in the biochemical nature of the four *M*-genes have as yet been demonstrable

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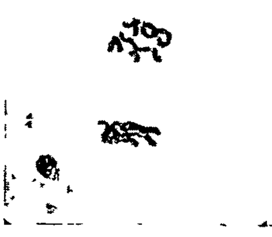
## Colchicine-induced Tetraploidy in *Luzula purpurea* Link

*Luzula purpurea* has been the subject of constant research in our laboratory since Malheiros and Castro[1] observed the unusual behaviour of its chromosomes

In the spring of 1950, we succeeded in inducing tetraploidy in seedlings of this species, after immersing aerial parts in a 0 5 per cent colchicine solution Following this treatment, the plants exhibited a striking growth retardment and delay in flowering One of the treated plants showed the usual morphological characteristics of induced tetraploids, mainly more pointed and thicker leaves with a darker green colour

Cytological analysis of pollen mother cells revealed chromosome duplication, namely, $2n = 12$ instead of $2n = 6$ Moreover, it was observed that these chromosomes were shorter and thinner compared with the normal ones in diploid plants

Chromosome behaviour is, in most cases, similar to that described by Malheiros, Castro and Camara[2]. Throughout prophase and metaphase I, they form polyvalent associations, and at anaphase I, 12 chromatids may clearly be seen going to the poles



1

2

Diads are thus formed with 12 daughter chromosomes in each nucleus (Fig 1) Metaphase II proceeds in the normal way for the species, and after anaphase II, 6 chromosomes are included in each telophasic nucleus (Fig 2) Every other division until pollen germination seems to follow closely the general features described earlier[1]

In a few cases irregularities were noticed, as, for example, tetrads with 5 and 6 nuclei, containing each a variable number of chromosomes, but never less than 3

Pollen grains enclosed within the common membrane show a striking swelling, giving the tetrads a very pronounced lobulate appearance

A more detailed cytological study of these autotetraploids will be published shortly

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## Effect of Azide on the Respiratory System of *Aerobacter aerogenes*

SODIUM azide, a substance which has been widely used in the study of various metabolic problems, is known to have three main effects (*a*) it combines with several metallo-proteins, in particular with hæmatin compounds, a9d thus strongly inhibits respiration[1], (*b*) it inhibits processes of assimilation and synthesis in micro-organisms[2], and (*c*) it interferes with the oxidative metabolism of cells by preventing the uptake of inorganic phosphate[3] The last two effects arise probably from the same cause[4] The inhibition of respiration is usually very strong and will tend to mask any other effects Some cases of azide-resistant respiration have been reported[5], but the phenomenon could not be explained

For the following experiments a strain of *Aerobacter aerogenes* kindly given to me by Dr E F Gale was cultivated in ordinary broth medium at 30° C The cells from 16-hr cultures were thoroughly washed with water and resuspended in 0 1 *M* phosphate buffer Respiration-rates were measured in Barcroft manometers at 30° C With glucose as substrate, the respiration of the bacteria was not inhibited by sodium azide, even in concentrations as high as $M/100$ at *p*H's varying between 5 5 and 7 8 In fact, a marked acceleration was observed However, in presence of succinate or acetate, $M/300$ azide inhibited the oxygen uptake by more than 60 per cent At first sight one might suppose that the oxidation of glucose does not proceed through the same final chain of reactions as does succinate or acetate But with these substrates the anaerobic reduction of methylene blue, as measured in Thunberg tubes, was inhibited by azide to the same degree (more than 60 per cent) as was the respiration in manometers It thus appears that the site of the inhibitory action is a dehydrogenase rather than the final step in the oxidation reaction chain, *namely*, the cytochromes. Further evidence in favour of this view was obtained in spectroscopic experiments which clearly indicated that azide did not combine with any of the cytochrome components of this organism

In the oxidation of glucose, $M/300$ azide increased the oxygen uptake by more than 100 per cent and the rate of anaerobic reduction of methylene blue by 300–400 per cent This action was highly specific for glucose, with fructose, a sugar which was oxidized at the same rate as glucose, or with galactose, azide did not produce any appreciable increase in the rate of oxygen uptake or of anaerobic reduction of methylene blue (Table 1) Moreover, azide had no effect on pyruvate oxidation, a substance which was formed in very large amounts during the oxidation of glucose, and must therefore be an important intermediate in its aerobic breakdown These facts show that azide probably acts on the earlier steps of glucose oxidation When washed cells were suspended in glycyl–glycine buffer plus glucose, a similar acceleration by azide was observed

Table 1 EFFECT OF AZIDE ON THE RESPIRATION AND ON THE ANAEROBIC REDUCTION OF METHYLENE BLUE BY *Aerobacter* IN THE PRESENCE OF VARIOUS SUBSTRATES

| | $Q_{O_2}$ | | Methylene blue reduction time (sec ) | |
|---|---|---|---|---|
| Substrate | Without azide | With $M/300$ azide | Without azide | With $M/300$ azide |
| Glucose | 117 | 245 | 170 | 50 |
| Fructose | 119 | 116 | 165 | 145 |
| Galactose | 51 | 54 | 190 | 170 |

Table 2. EFFECT OF AZIDE ON THE AEROBIC BREAKDOWN OF GLUCOSE BY *Aerobacter aerogenes* AT 30°
6 5 mgm bacteria (dry wt ) Duration of experiments, 30 min Results expressed in $\mu$moles

| | Without azide | With $M/300$ azide |
|---|---|---|
| Oxygen uptake | 8 25 | 17 |
| Glucose utilized | 4 06 | 8 06 |
| Pyruvic acid found | 4 7 | 6 7 |
| Lactic acid found | 1 0 | 0 8 |
| Carbon dioxide output | 6 25 | 14 5 |
| Respiratory quotient | 0 76 | 0 85 |

A preliminary study of the action of azide on the intermediary metabolism of glucose was made in the following way Oxygen uptake and carbon dioxide output were measured by the Dixon–Keilin method[6] and the amount of glucose utilized during the experiment was estimated, as were also the pyruvic and lactic acids present at the end of the experiment (Table 2) The quantities of oxygen taken up, carbon dioxide produced and glucose utilized were all doubled by azide, the quantity of pyruvic acid formed was increased by 50 per cent, whereas that of lactic acid was slightly decreased It is interesting to note that the quantity of pyruvic acid was exceptionally high, even in absence of azide, whereas in anaerobic experiments only very small amounts were found The carbon deficit, especially in the presence of azide, is probably due to the formation of acetate, for which no analytical figures are available.

Further experiments will show whether the specifi action of azide on the oxidative breakdown of glucos is related to phosphorylation

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## Physiological Effects of Trihydroxy-N-Methylindol and its Reaction with Copper Ions

TRIHYDROXY-N-METHYLINDOL, a highly fluorescent substance derived from adrenochrome[1–4], sensitizes the smooth muscles of the cat to the excitatory (nictitating membrane) and inhibitory (non-pregnant uterus) actions of adrenaline[5]

This substance has a great affinity for copper ions The fluorescence of a $2 \times 10^{-6}$ solution disappears in three minutes at laboratory temperature in the presence of $1 \times 10^{-6}$ copper ions (as copper sulphate), it inhibits the oxidation by copper ions of adrenaline in aqueous solution. A substance has been isolated and analysed which corresponds to the formula $C_9H_7NO_3Cu + H_2O$ or $C_{18}H_{14}N_2O_6Cu_2 + 2 H_2O$ (found C, 42, H, 3 6, N, 5 1, $C_{18}H_{14}N_2O_6Cu_2$ requires C, 41 5, H, 3 5, N, 5 4 per cent)

The hypothesis may be put forward that the physiological actions of trihydroxy-N-methylindol (decrease of bleeding time[6] and of capillary permeability, sensitization to adrenaline) are related to its copper-binding activity in accordance with the general concept formulated by Lavollay[7], Javillier and Lavollay[8], Clark and Geissman[9], in order to explain the 'vitamin P'-like actions of flavonoids and related substances

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## 'Y-Protein': a New Component of the Muscle Machine

WE have recently shown[1] that if rabbit muscle is extracted with a solution of *high* ionic strength (potassium chloride > 0 5), the electrophoretic test (Tiselius–Longsworth, see ref 2) shows, besides the proteins already described[3–7], a new component that we have called '*Y*-protein'. At ionic strength 0 40 and *p*H 7 4, it moves more slowly than β-myosin

This new protein exists only in extracts of normal resting muscle If the muscle has been previously subjected to contracture by pharmacological means monoiodoacetate) or *rigor mortis*, neither *Y*-protein or β-myosin can be found in the extracts if potassium hloride is used for the extraction[6] This is due to the esence of strong linkages between those proteins and iscle stroma, in the contracted state These linkages not be broken by potassium chloride, but are broken potassium iodide or pyrophosphate solutions[1].

e have succeeded in isolating *Y*-protein Normal ng muscle is progressively frozen in a − 20° C ber, cut in 50-μ slides by use of a freezing-tome[8], extracted for ten minutes with 5 vol –Edsall solution (0 6 *M* potassium chloride, sodium bicarbonate, 0·01 *M* sodium carbonate, the addition of 0 3 per cent adenosinetriphosphate does not affect the amount of *Y*-protein extracted) Extraction and the following operations are carried out in a cold room at ± 1° C After centrifugation, the liquid is progressively mixed with saturated ammonium sulphate solution at *p*H 6 00 (53 c c sulphate solution for 100 c c extract, which corresponds to 35 per cent saturation)

The electrophoretic analysis of the precipitate shows that it contains α-myosin (actomyosin), *Y*-protein and some myogenes β-myosin remains in the solution (it is precipitated only at 37–40 per cent saturation in ammonium sulphate at *p*H 6 00 [9]) The precipitate containing *Y*-protein is washed with ammonium sulphate solution at 35 per cent saturation and dissolved in 0 1 *M* potassium chloride at *p*H 7 6 The solution, which is rather turbid owing to the presence of actomyosin, is dialysed against a solution of μ 0 05 (0 016 disodium hydrogen phosphate, 0 002 sodium dihydrogen phosphate) The actomyosin is precipitated and *Y*-protein remains in the solution

Electrophoretic controls show that only one component is present Its velocity is

at μ 0 40, *p*H 7 40 $- 2\ 7 \times 10^{-5}$ cm /volt/sec
at μ 0 10, *p*H 7 60 $- 3\ 4 \times 10^{-5}$ cm /volt/sec

In an extract of whole muscle, in which *Y*-prote is present as well as all the other muscle proteins, t velocity of the *Y*-protein is much reduced

at μ 0 40 and *p*H 7 40 $2\ 65 \pm 0\ 1 \times 10^{-5}$ cm /volt/sec

Solutions of *Y*-protein are rather clear, slightly viscous and do not show double refraction of flow Optical properties do not depend on ionic strength between 0 005 and 0 5

*Y*-protein is insoluble in distilled water, fairly soluble in solutions at μ 0 005, *p*H 7 4 The fact that the new protein can be extracted only by using solutions of at least a hundred times ionic strength indicates that *Y*-protein is not free in the muscle cell, but connected to some part of the insoluble stroma from which it is liberated by solutions of high ionic strength

This property explains why *Y*-protein has not been isolated before It cannot be present in low ionic strength extracts such as those prepared for isolation of the proteins of the myogen group or the *X*-globulins When extracts of high ionic strength are made, they are usually prepared to extract the myosins—which are precipitated by dilution—and *Y*-protein is not precipitated in those conditions, being still soluble at μ 0 005 *M*

That the binding forces which maintain the *Y*-protein in the muscle cell are considerably increased in the contracted state seems to be a proof that the new protein takes part in the constitution of the muscle machine

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## Folic Acid, Vitamin B$_{12}$ and Nucleic Acid Synthesis in *Lactobacillus casei*

A RELATIONSHIP between folic acid and certain constituents of nucleic acids in micro-organisms has been known for some time[1]. This has been ascertained more directly by the recent demonstration[2] that partial deficiency of folic acid in a medium otherwise favourable for rapid growth of *Lactobacillus casei* results in impairment of the synthesis of deoxyribonucleic acid but not of ribonucleic acid According to Stokes[3], folic acid may function in an enzyme system responsible for the synthesis of thymine, which in turn is used for forming nucleic acids Presumably, this takes place through its deoxyriboside hymidine with involvement of vitamin B$_{12}$ [4], the nediation of which in nucleic acid synthesis has also een shown[5] This and other functional relationships etween folic acid and vitamin B$_{12}$ [6] suggested an nvestigation of their effects, singly and together, on nucleic acid metabolism

With *L casei* (*ATCC* 7469) grown in a medium[2] varied with respect to concentrations of folic acid (Lederle) and vitamin B$_{12}$ (crystalline, Merck), some results of a typical experiment are set forth in the accompanying table Nucleic acids were extracted by Schneider's procedure[7] Ribonucleic acid was termined by the orcinol method[8] and deoxyribocleic acid by the diphenylamine reaction[9] in suitle aliquots of this extract

| Supplement | Ribonucleic acid* (per cent) | Deoxyribonucleic acid* (per cent) | Cell mass* (gm per lit ) | 0 1 *N* acid† per 10 c c medium (c c) |
|---|---|---|---|---|
| Folic acid 5 μgm /100 c c | 9 09 | 1 87 | 0 21 | 2 5 |
| ,, ,, 200 ,, ,, | 8 42 | 2 82 | 0 48 | 12 14 |
| Vitamin B$_{12}$ 5 ,, , | 9 39 | 1 25 | 0 21 | 2 26 |
| ,, 200 ,, ,, | 9 50 | 2 93 | 0 24 | 7 50 |
| Folic acid + vitamin B$_{12}$ 5 μgm each/100 c c | 10 26 | 2 26 | 0 20 | 2 38 |
| ,, ,, ,, 20 ,, ,, | 9 74 | 2 50 | 0 30 | 4 76 |
| ,, , ,, 200 ,, ,, | 9 28 | 3 82 | 0 68 | 12 43 |

* 24-hr growth, † 72-hr growth

As may be expected, folic acid enhances the synthesis of deoxyribonucleic acid Similar results are obtained with vitamin B$_{12}$ although, from growth and acid production, it is seen that it could not ompletely replace folic acid as a growth factor for *casei*. The interesting observation, however, is at there is a pronounced, and more or less all-round additive, effect of folic acid and vitamin B$_{12}$ Other related metabolic activities are being studied

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## Methionine and the Formation of Pigment by Yeasts

YEAST 47 [1] grows well in a defined salts–glucose–ammonia medium, containing *p*-aminobenzoic acid, biotin, pantothenic acid and inositol[2] This medium, supplemented with 500 μgm of L- (or 1,000 μgm. of DL-) methionine per ml, but containing suboptimal concentrations (0 003–0 04 mμgm /ml ) of D-biotin, yields yeast crops after 72–96 hr at 28° which are unusual in that they are pink in colour Other conditions being suitable, the colour is not formed (1) if any other amino-acid is substituted for methionine; (2) if the concentration of D-biotin is raised to 0 08 mμgm /ml, (3) in the presence of optimal biotin, but suboptimal pantothenate, *p*-aminobenzoic acid or inositol Formation of the pink pigment is thus associated with the presence of methionine and with a relative deficiency of biotin.

If, however, *p*-aminobenzoic acid is omitted from the medium and replaced by adenine, methionine and histidine[1,2], no pigment is formed, nor is it possible to induce pigment formation in a strain of *Schizosaccharomyces octosporus* examined in these laboratories[3] which requires adenine, methionine and histidine for growth Again, under conditions otherwise suitable, but in the presence of 25 μgm of adenine hydrochloride per ml of medium, pigment formation by yeast 47 is almost, if not entirely, suppressed These observations, which suggest that a precursor of adenine is a further factor in pigment formation, are possibly related to those of Lindegren and Lindegren[4] who associate the formation of a pink pigment by an artificially induced mutant of *Saccharomyces cerevisiæ* with the interaction of excess methionine with a precursor of adenine (formed as the result of a 'genetic block' in adenine synthesis) and with other substances

Pigment formation by yeasts under the conditions described is not confined to yeast 47, having been induced in strains of *Schizosaccharomyces pombe*, *Saccharomycodes ludwigii*, *Saccharomyces carlsbergensis* and five single-cell strains of brewer's yeasts (*S cerevisiæ*) Certain of these strains form pigment in absence of exogenous methionine, possibly because relatively large amounts of methionine are synthesized by the cell.

It is also noteworthy that, wherever the yeast crops are pink, a diazotizable amine (not *p*-aminobenzoic acid) is present in the fermented medium The amine is not present when the nutritional environment is such that normal, creamy-white yeast crops are obtained

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## Use of Antisera to identify Nodules produced by the Inoculation of Legumes in the Field

In field trials with leguminous crops 'inoculated' with nodule bacteria (*Rhizobium*), it is sometimes important to know what percentage of the nodules that may develop are, in fact, produced by the culture used for inoculation This problem arose in some work the object of which was to replace ineffective strains of *Rhizobium trifolii*, which are abundant in some British soils, with a more effective strain used for inoculating clover It was first important to discover whether the inoculant strain could be established in the nodules of the crop under field conditions in which it would have to compete with the native population of *Rhizobium trifolii* already present in the soil In inoculation trials on such soils, a proportion of the nodules formed in the inoculated plots will be produced by native *Rhizobium* of which a considerable variety of strains may be present Isolations can readily be made from nodules taken at random from the crop roots, but the identity of these isolates with the strain used for inoculation is difficult or even impossible to determine by cultural methods, because of the similarity between strains of *Rhizobium* in their appearance and behaviour on laboratory media.

Table 1

| Locality | Soil type | Experimenter |
|---|---|---|
| Bosley Brook, Macclesfield, Cheshire | Peat | E C E Hemsted |
| Macaulay Institute of Soil Research, Aberdeen | Loam | A B Stewart |
| Woburn Experimental Station, Bedfordshire | Sandy | H H Mann |
| Essex Institute of Agriculture, Writtle, Essex | Clay | B H Harvey |

The antigenic constitution of *Rhizobium trifolii* (and probably of other groups of *Rhizobium*) is of such a type as to suggest the use of serological tests for this purpose Agglutination reactions have not shown the presence of any antigens common to all strains but have revealed a number of somatic and flagellar antigens, any of which is found in some strains but not in others, some of these have been found in very few strains Tests with antisera against six *Rhizobium* strains were made on 161 strains of *Rhizobium trifolii* from soils taken over a wide area in Great Britain Only seven of these were found capable of agglutination by antiserum against strain *P* 11 and only ten by antiserum against strain 205 It thus seemed possible that the presence of the inoculant strain in the nodules of the crop could be determined by simple agglutination tests on isolates from these nodules, if the strain chosen for inoculation contained one of the uncommon antigens likely to be absent or rare in the local population of *Rhizobium trifolii* Its scarcity among these local strains could be checked by testing isolates from uninoculated plots

To test the feasibility of this idea, small field experiments with Montgomery red clover were laid down and sown in September 1943 at the localities shown in Table 1

Plots were sown with uninoculated seed, others with seed inoculated with *Rhizobium* strain *Cl F*, which is agglutinated with antiserum against strain *P* 11, and others with seed inoculated with strain 205 Both these strains produce nodules effective in fixing nitrogen In the Macaulay experiment triplicate, and at Bosley Brook and Woburn duplicate, plots two yards square were laid down, the treatment being disposed at random At Writtle larger single inoculated plots 100 ft × 50 ft were separated and flanked by uninoculated plots Inoculations were carried out with suspensions in skim milk of bacteria from agar slopes

After two to three months growth, clover plants, taken at random from the plots, were lifted, and isolations of *Rhizobium* were made from nodules also taken at random A second sampling of plants from the Macaulay experiment was made in the early summer of 1944 The isolates from plots inoculated with strain *Cl F* were tested with antiserum against strain *P* 11, those from plots inoculated with strain 205 with homologous antiserum against this strain, and those from the uninoculated plots with both antisera The serological technique used was as described by Kleczkowski and Thornton[1] Table 2 shows the total numbers of isolates tested from each plot in the four experiments and the numbers that gave 0-type agglutination with the test antisera

Taking all the experiments together, more than half the nodules from plots inoculated with strain *Cl F* contained bacteria that were agglutinated with serum against *P* 11, and only one of the ninety-two isolates from uninoculated plots reacted with this antiserum Strain 205 was much less successful in infecting the crop Bacteria that reacted with antiserum against 205 were found in only fourteen of the ninety-two nodules taken from plots inoculated with this strain But here also serological identification of the inoculum in these nodules was supported by the fact that only two of the isolates from uninoculated plots reacted with 205 antiserum

These experiments thus suggest the feasibility of using specific antigens as tracers to follow the

Table 2 TESTS OF *Rhizobium* ISOLATES FROM INOCULATED CLOVER RESULTS FROM INDIVIDUAL PLOTS

| Locality | Plots inoculated with strain *Cl F* | | Plots inoculated with strain 205 | | Uninoculated plots | | |
|---|---|---|---|---|---|---|---|
| | Total nodules tested | Positive to *P* 11 antiserum | Total nodules tested | Positive to 205 antiserum | Total nodules tested | Positive to *P* 11 antiserum | Positive to 205 antiserum |
| Macaulay First sampling | 6 | 3 | 6 | 1 | 6 | 0 | 0 |
| | 6 | 4 | 6 | 0 | 6 | 0 | 0 |
| | 6 | 3 | 6 | 1 | 6 | 0 | 0 |
| Macaulay Second sampling | 6 | 3 | 6 | 0 | 6 | 0 | 0 |
| | 6 | 4 | 6 | 1 | 6 | 0 | 0 |
| | 6 | 3 | 6 | 2 | 6 | 1 | 1 |
| Bosley Brook | 10 | 9 | 10 | 4 | 10 | 0 | 1 |
| | 10 | 9 | 10 | 3 | 10 | 0 | 0 |
| Woburn | 9 | 5 | 9 | 1 | 9 | 0 | 0 |
| | 9 | 3 | 9 | 0 | 9 | 0 | 0 |
| Writtle | 18 | 5 | 18 | 1 | 18 | 0 | 0 |
| Total, all localities | 92 | 51 | 92 | 14 | 92 | 1 | 2 |

behaviour of an inoculant strain of *Rhizobium* in infecting the crop in the field. Identification can be made more certain by the use of more than one test antiserum that reacts with the inoculant strain and by including specific *H*-type reactions By such means inoculant strains containing specific combinations of less rare antigens should be identifiable A development of the technique suggested here has been used successfully in more recent experiments carried out in this Department, the results of which will be published elsewhere

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[1] *J Bact* , 48, No 6 661 (1944)

## Effect of Molybdenum Status on the Ascorbic Acid Content of Plants in Sand Culture

The role of molybdenum in higher plants is generally thought to be closely connected with the assimilation of nitrate nitrogen[1,2] Requirements appear to be much reduced with ammonium nitrogen[2], but recent work here has shown that presence of ammonium and nitrate together does not eliminate the need The nature of the system involved in nitrate assimilation and the step activated by molybdenum are still obscure The suggestion that ascorbic acid may function in plants as an agent for nitrate reduction is not new[3], but has been given little consideration Recently, Virtanen and his associates[4,5] have found that seedlings given nitrate nitrogen may be unable to grow if the cotyledons or endosperm are removed unless ascorbic acid or glutathione or other reducing agents are supplied, whereas excised seedlings given ammonium nitrogen continue normal development in the absence of any supplements These observations were attributed to the *in vivo* effect of ascorbic acid in the seed reserves on nitrate reduction No information was available, however, as to the molybdenum status of their cultures There are also reports which indicate that plants supplied with nitrate contain less ascorbic acid than those grown with ammonium nitrogen[6-8] Other nutritional effects so far reported, except possibly that of manganese[9], seem to have comparatively little or no consistent influence

In the course of a general investigation of possible means of nitrate or nitrite reduction in plants, it seemed of interest to determine whether molybdenum status might influence the ascorbic acid content of plants under controlled sand culture conditions Preliminary results given in the accompanying table indicate that molybdenum deficiency consistently causes a striking (and generally significant) reduction in the apparent ascorbic acid content of several crops (as determined by rapid titration of leaf extracts in 5 per cent metaphosphoric acid in copper-free water with 2 6 chlorophenol-indophenol) Molybdenum-deficient plants were also injected through the petioles with 2–400 μgm molybdenum in 12–24 hr , while other plants in the *same containers* remained uninjected There was a detectable rise in ascorbic acid content in 24 hr , this increased to double that of the non-injected plants in 3–5 days and attained 75–95 per cent of normal (molybdenum-supplied) plants These effects were significant The first visual response to molybdenum was just perceptible in three days as chlorophyll formation, and growth-response could be detected about seven days after injection No further increase in ascorbic acid occurred when molybdenum was supplied to normal plants in excess of the optimum requirement Molybdenum-deficient cauliflower plants given ascorbic acid in the nutrient showed fresh chlorophyll formation after about seven days, followed by renewed growth Addition of ascorbic acid to molybdenum-deficient cultures of *Aspergillus niger* produced a similar growth response, and normal cultures had a higher reducing activity The ascorbic acid content of cauliflower plants, kindly provided by Dr W Plant from a field-trial on an acid soil (Lower Greensand, *p*H 5 5), and showing typical symptoms of molybdenum deficiency[1], was also significantly less than in normal plants which had been treated with molybdenum

| Crop | Ascorbic acid (mgm /100 gm ) (mean values) | | – Mo as % of + Mo |
|---|---|---|---|
| | – Mo | + Mo | |
| Tomato | 56 1 | 121 1 | 45 2 |
| Brussels sprouts | 48 9 | 155 3 | 31 4 |
| Marrowstem kale | 58 2 | 169 9 | 34 2 |
| Cauliflower | 65 7 | 263 9 | 24 9 |
| Rape | 55 2 | 190 7 | 28 0 |
| Savoy cabbage | 68 5 | 184 5 | 37 1 |
| Alsike clover | 92 5 | 209 0 | 44 2 |
| Barley | 56 5 | 139 5 | 40 5 |
| Sugar beet | 25 6 | 75 4 | 33 9 |

It would seem that neither disparity in growth nor lack of chlorophyll *per se* accounts for the effect of molybdenum Any assumption that molybdenum *directly* activates a reaction between ascorbic acid and nitrate or nitrite would require the expectation of *reverse* results from those reported, and in any event ascorbic acid can reduce nitrite and is decomposed slowly also by nitrate non-enzymatically and without metallic activation at 30–35° C [10] The failure to obtain further response to injection of additional molybdenum into normal plants does not exclude the possible role of this element in ascorbic acid synthesis, as lack of precursors might have limited further production

Two other possibilities, however, at present equally compatible with the results obtained, merit consideration Crook and Morgan[11] found that the reduction of dehydroascorbic acid by glutathione, although appreciable chemically, was greatly accelerated in many plant extracts by an enzymic system probably distinct from the systems responsible for ascorbic acid oxidation, and suggested this mechanism was responsible for the 'protective action' of sulphydryl groups Waygood[12] and Davison[13] suggested that ascorbic acid is cyclically oxidized and reduced in systems linked to malic dehydrogenase in wheat and formic dehydrogenase in pea The possibility of linkage between nitrate reduction in higher plants and an anaerobic dehydrogenase via the catalytic influence of ascorbic acid (and dehydroascorbic acid) and its 'protective' intermediates[11,12] seems feasible Activation of either the dehydrogenase or the dehydroascorbic reductase by molybdenum might account for the results obtained here

The alternative to be considered at present is that molybdenum may activate some other system responsible for rapid nitrate reduction When this system fails to operate, the accumulated nitrate[1,2] may then cause oxidative loss of ascorbic acid extra to that due to other known systems The disturbance of the normal ascorbic acid equilibrium in the plant might contribute to the characteristic symptoms caused by molybdenum deficiency These views appear consistent with the requirements for molybdenum in the presence of different nitrogen supplies observed described above

It is hoped to test, and distinguish between, these possibilities by investigations now in progress and to be reported later elsewhere

Acknowledgment is made to the Agricultural Research Council for providing special apparatus for work on molybdenum deficiency One of us (E W J) is also indebted to the Council, and another (S C A) to the U P Government, India, for providing grants which have enabled them to participate in the work We also wish to acknowledge the advice of Dr A Pollard on the estimation of ascorbic acid in plant extracts.

E. J Hewitt
S C Agarwala
E W. Jones

Long Ashton Research Station,
University of Bristol. July 29.

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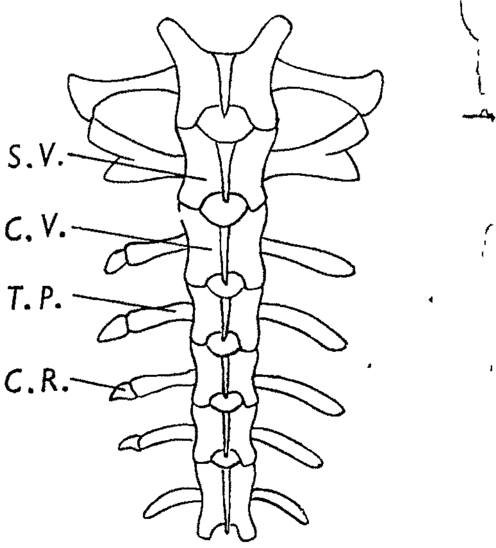
## Caudal Ribs in Geckos

During a comparative study of the osteology of some Egyptian geckos, including *Stenodactylus stenodactylus*, *Tropiocolotes tripolitanus*, *T. steudneri*, *Ptyodactylus hasselquistii*, *Hemidactylus turcica*, *Tarentola mauritanica* and *T annularis*, a rather interesting detail concerning the caudal region of the vertebral column was observed, which has not previously been recorded in living Lacertilia so far as we are aware It concerns the presence of caudal ribs in geckos Among the above-mentioned species, such ribs were found in both *Tarentola annularis* and *Ptyodactylus hasselquistii*

As a matter of fact, the caudal vertebræ of Lacertilia are provided with prominent transverse processes, which are particularly well developed in some lizards such as *Uromastyx ægyptia*[1] It was found that in both *Tarentola annularis* and *Ptyodactylus hasselquistii* the transverse processes of the anterior caudal vertebræ carried at their distal ends small pieces of bone representing caudal ribs These ribs are clearly articulating with the transverse processes, as seen in skeletons stained with alizarine and cleared according to Hollister's method[2] They are present on one side of the body only (see accompanying illustration) On the opposite side, the lateral process of each rib-bearing vertebra is equal in length to both the transverse process and caudal rib of the same vertebra It is therefore reasonably assumed that the caudal ribs, which are freely articulating with the transverse processes of one side, are completely fused with the corresponding processes of the opposite side



*Tarentola annularis* Dorsal view of the two sacral vertebræ and the anterior five caudal vertebræ *C R*, caudal rib, *C V*, caudal vertebra, *S V*, sacral vertebra, *T P*, transverse process

In primitive Tetrapoda ribs are present in the different parts of the vertebral column, including not only the cervical, dorsal and sacral, but also the caudal region Thus Williston[3] states that in Amphibia and reptiles the ribs "primitively articulate with all vertebræ, at least as far back as the middle of the tail" In the fossil amphibian *Eogyrinus* the anterior caudal vertebræ are provided with rib facets, as described by Watson[4] Long and massive caudal ribs, which are quite similar to the dorsals, have been also described by Watson[5] in the fossil reptile, *Seymouria* Thus the well-developed caudal ribs described in fossil Tetrapoda are still retained in the form of a series of rudimentary structures present in the caudal region of some living geckos

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## *p*-Hydroxybenzoic Acid: a New Bacterial Vitamin

Mutant 83-1 of *Escherichia coli*, isolated by the penicillin method[1], is blocked at an early stage in aromatic synthesis, it responds to a quadruple supplement of tyrosine, phenylalanine, tryptophan and *p*-aminobenzoic acid Whereas the quantitative requirements for the three amino-acids are similar to those of mutants with single requirements for these compounds, growth is very slow with 0 005 μgm/ml of *p*-aminobenzoic acid, a concentration sufficient for optimal growth of a mutant blocked specifically in $p$-aminobenzoic acid synthesis Higher concentrations of the acid, up to 1 µgm /ml , provide more rapid, yet less than normal, growth of mutant 83-1 Normal growth-rate, however, appears with the addition of shikimic acid (a 2,3,4,5-tetrahydrogallic acid)

Shikimic acid has been reported to be a precursor of the above four aromatic metabolites[2] [3] The facts presented here lead one to postulate a fifth metabolite, compound *Y*, that can be formed readily from shikimic acid and less readily from $p$-aminobenzoic acid A substance with *Y* activity was, indeed, found in culture filtrates of the parent wild type, and was distinguished by paper chromatography (using response of 83-1 for recognition) from $p$-aminobenzoic acid and shikimic acid Chromatography was complicated by the presence of *Y* activity in the paper (Whatman No 1)

The derivation of *Y* from shikimic acid or $p$-aminobenzoic acid in the cell suggested the possibility of a simple aromatic structure The activity in filter paper further suggested that the substance involved might already be known from studies on wood chemistry Fifty available aromatic compounds were therefore tested Among these, only $p$-hydroxybenzoic acid was active, as little as 0 01 µgm /ml supported rapid growth of 83-1 in the presence of its quadruple supplement The active materials in culture filtrate and filter paper were indistinguishable from $p$-hydroxybenzoic acid by paper chromatography with three solvents The high order of activity shown by $p$-hydroxybenzoic acid leads us to propose that it be considered a bacterial vitamin It may be further noted that wild type *E coli* also excretes several other vitamins, including $p$-aminobenzoic acid[2]

The method of mutants has been widely used for the discovery of metabolic precursors, the present observations represent an extension to the recognition of a new metabolite We have found $p$-hydroxybenzoic acid, like $p$-aminobenzoic acid, in significant concentrations (relative to microbiological requirements) in yeast autolysate but not in liver extract. $p$-Hydroxybenzoic acid, therefore, has promise as a model for synthesis of chemotherapeutic analogues selectively toxic to micro-organisms This hope is encouraged by the observation that the growth-slowing effect exerted on *E coli* by 100 µgm /ml of 4,4′-dihydroxydiphenyl sulphone (kindly furnished by Dr M E Hultquist of the American Cyanamid Company) is partly overcome by 0 1 µgm /ml of $p$-hydroxybenzoic acid

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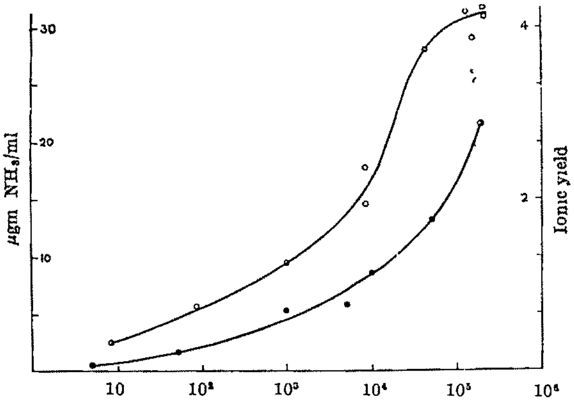
## Deamination of Aqueous Solutions of L-Serine by X-Radiation

THE deamination of glycine by X-radiation[1] is dependent on the concentration of the glycine solution in a way that is different from the more common relationship of yield/concentration found for solutions of many inorganic solutes[2] and viruses[3], and, for example, carboxypeptidase[4] The inactivation of this enzyme by X-radiation is independent of the concentration over a wide range, except in extremely dilute solutions (less than $3 \times 10^{-6}$ *M*) The yield of ammonia, however, from glycine and other amino-acids shows a continuous rise up to nearly saturated solutions, that is, an approximately 20 per cent solution in the case of glycine The liberation of sulphur from thiourea[5] follows a similar course The yield/concentration relationship is not confined to substances of low molecular weight, for McDonald has recently found[6] that trypsin, which has apparently the same molecular weight as carboxypeptidase, also shows a similar rise up to a 1 per cent solution (the highest concentration which could be used for technical reasons)

It was of interest to find conditions under which it would be possible to show that the rise of yield with concentration of the amino-acid, which cannot be expected to continue indefinitely, would show signs of a 'levelling off' Glycine, while possessing a reasonably high solubility, has too low an ionic yield for this purpose On the other hand, DL-serine, which has the advantage of an ionic yield almost double that of glycine at equimolar concentrations (ionic yield for DL-serine is 4 2 for a 5 per cent or nearly saturated solution), is far too insoluble



Yield/concentration curve ○—○—, L-serine, ●—●—, glycine X-ray dose, 166,000 r

L-Serine, however, combines the two features—high solubility and high enough ionic yield—desirable for a study of this kind The accompanying graph compares the deamination of glycine and L-serine over the complete range of concentrations and shows that, in general, the curves for both acids follow similar trends In the L-serine curve, however, at nearly saturated solution there is a distinct 'levelling off' tendency in the yield of ammonia All solutions in this investigation were air-saturated, and the concentrations stated are weight of amino-acid/ml of solution

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# FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

### Tuesday, January 2—Friday, January 5

International Association for Hydraulic Research (at Bombay, India)

### Tuesday, January 2—Saturday, January 6

British Trust for Ornithology (at the Edward Grey Institute, Oxford)—Annual Conference on "Bird Biology for Students"

### Wednesday, January 3

Institute of Fuel (at the James Watt Institute Great Charles Street, Birmingham), at 2 30 p m —Papers on "Drying of Fuel, Sand, etc" *

Manchester Federation of Scientific Societies (in the Chemistry Lecture Theatre, The University, Manchester), at 3 p m —Prof H Graham Cannon, F R S "Animals that Live in the Sea' (Christmas Lecture for Young People) (To be repeated on Thursday, January 4, at the same time and place )

Royal Meteorological Society (at 49 Cromwell Road, London, S W 7), at 5 p m —Mr F H Ludlam "Clouds" (Vacation Meeting )

Royal Photographic Society, Kinematograph Section (joint meeting with B K S at Film House Wardour Street, London, W C 2), at 7 p m —Mr Brian Langley The Split Beam Process"

### Thursday, January 4

Institute of Metals, Birmingham Section (at the James Watt Memorial Institute Great Charles Street, Birmingham), at 6 30 p m —Discussion on ' Temperature Measurements"

British Institution of Radio Engineers, North-Western Section (at the College of Technology, Manchester), at 6 45 p m —Mr G W L Davis "Marine Radar"

Institution of Works Managers, Bristol Branch (at the Royal Hotel, Bristol), at 7 15 p m —Mr A B Armstrong ' Motion Study"

### Friday, January 5

Institution of Works Managers, Notts and Derby Branch (at the Midland Hotel, Derby), at 7 30 p m —Mr J W Hendry Production Efficiency via Time Study"

### Saturday, January 6

British Interplanetary Society (in the Tudor Room, Caxton Hall, Westminster, London, S W 1) at 6 p m —A Symposium on The Orbital Rocket"

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned

Honours Graduates (with experience in medical or veterinary research, and specialization in experimental pathology bacteriology, virology or immunology) at a Ministry of Supply Research Establishment in South-West England— The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W C 2 quoting G 326/50 (January 6)

Lecturer in Chemistry—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (January 6)

Technical Officer (man, with a degree in Electrical Engineering and/or an equivalent professional qualification and industrial experience in heavy electrical engineering) as Assistant to the Head of the Electrical Engineering section of the Technical and Scientific Register —The Ministry of Labour and National Service, Technical and Scientific Register (K), York House Kingsway, London W C 2, quoting D 381/50A (January 6)

Honours Graduates (with experience in medical or veterinary research, and specialized in bacteriology, biochemistry, biophysics, immunology, virology or pathology) at a Ministry of Supply Research Establishment in South-West England—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London W C 2, quoting No G 339/50A (January 8)

Engineer Officers (Mechanical and Aeronautical) and Electrical Officers (with a previous commission in R N or a University degree of B Sc (Engineering) or acceptable equivalent) in the Royal Australian Navy—The Royal Australian Naval Liaison Officer, Dept L N A, Canberra House, 87 Jermyn Street, London, S W 1 (January 12)

Lecturer in Botany and General Biology—The Principal, Wigan and District Mining and Technical College, Wigan (January 15)

Lecturer or Senior Lecturer in the subject of Industrial Relations—The Secretary of University Court, The University, Glasgow (January 15)

Physicist—The Secretary to the Management Committee, Liverpool Radium Institute Liverpool (January 15)

Principal Scientific Officer (with a first- or second-class honours degree, preferably in Naval Architecture, or high professional attainments in that subject) in the Ship Division of the National Physical Laboratory, Teddington— The Secretary, Civil Service Commission, Scientific Branch, Trinidad House Old Burlington Street, London, W 1, quoting No 3408 (January 18)

Electrical Engineer or Physicist with knowledge of application of electronics (except radio) to scientific investigation and development work—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S W 1 quoting TT/281 (January 24)

Physicist with special knowledge of the properties of matter c of aerodynamics with reference to the problems of flow—The Nation Coal Board, Establishments (Personnel), Hobart House, Grosven Place, London, S W 1, quoting TT/282 (January 24)

Technical Secretary (with an honours degree in science, wi chemistry or fuel technology as major subjects, or an honours degree in technical science, in fuel technology or chemistry, or equivalent qualifications), Coal Research Section, North Ryde, Sydney— The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting No 3162 (January 29)

Professor and a Senior Lecturer in the Department of Local Government and Public Administration of the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square London, W C 1 (January 31)

Reader in Pathology at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (January 31)

Senior Lecturer in the Department of Pathology, University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, Senate House, University of London, London, W C 1 (January 31)

Lecturer in Educational Psychology—The Registrar, University College, Hull (February 10)

Junior Lecturers in Tropical Medicine, Protozoology and Helminthology— The Dean London School of Hygiene and Tropical Medicine, Keppel Street, (Gower Street), London W C 1 (February 28)

Professor of Philosophy at the University of the Witwatersrand Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1 (February 28)

Biochemist (who will also undertake hydrography), and Marine Biologists (2), in the West African Fisheries Research Institute being established in Sierra Leone—The Under Secretary of State, Colonial Office (Research Department), Sanctuary Buildings, Great Smith Street, London, S W 1

Electrical Engineer (hydro electric) to the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S W 1, quoting M 25728 B

Meteorologist in the East African Meteorological Department—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S W 1 quoting 27118/10/50

Works Engineer in the Division of Atomic Energy (Production) Ministry of Supply Factory, Capenhurst, to be responsible for all factory engineering services—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref CB/2

# REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

## Great Britain and Ireland

Anglo-American Council on Productivity Productivity Repor Packaging Pp xiii+58+11 plates (London and New York Anglo-American Council on Productivity, 1950 ) *2s 6d* [510

Philosophical Transactions of the Royal Society of London Series A Mathematical and Physical Sciences No 857, Vol 243 A Theory of the Origin of Microseisms By M S Longuet-Higgins Pp 36 *8s* No 858, Vol 243 Thermodynamics and Rheological Behaviour of Elasto-Viscous Systems under Stress By F H Garne A H Nissan and G F Wood Pp 37–66 *7s* (London Cambridg University Press, 1950 ) [51

Philosophical Transactions of the Royal Society of London Seri B Biological Sciences No 619, Vol 234 The Transplantation of Normal Tissues, with Special Reference to Auto- and Homotransplants of Thyroid and Spleen in the Anterior Chamber of the Eye, an subcutaneously, in Guinea-pigs By M F A Woodruff and Hazel G Woodruff Pp 559–582+plates 28–30 (London Cambridge University Press, 1950 ) *11s* [510

## Other Countries

Proceedings of the American Academy of Arts and Sciences Vol 78, No 3 Some Interspecific Relationships in *Phacelia* subgenus *Cosmanthus*, by Lincoln Constance, On the Theory of Acoustic Radiation Pressure by J S Mendousse, Thermodynamic Relation in *n*-Variable Systems in Jacobean Form, Part 1, General Theory and Application to Unrestricted Systems, by F H Crawford Pp 135-184 1 25 dollars Vol 78 No 4 The Lower Permian Insects of Kansas, Part 10, The Order Protorthoptera—The Family Liomo teridae and its Relations By Frank M Carpenter Pp 185-219 1 dollar (Boston, Mass American Academy of Arts and Sciences 1950 ) [51

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